# 2021 Coyote Creek Watershed Fisheries Monitoring

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Reports included:

2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Coyote Creek

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# 2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Coyote Creek

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# 1. Introduction

On February 20, 2020 the Federal Energy Regulatory Commission (FERC) ordered the Santa Clara Valley Water District (Valley Water) to “begin draining the reservoir (Anderson) to deadpool, 488 ft elevation as quickly and safely as possible starting no later than October 1, 2020”. This effort is referred to as the FERC Order Compliance Project (FOCP). FOCP or the action of lowering the reservoir to deadpool could have consequences for downstream natural resources including Federally threatened Central California Coast steelhead (*Oncorhynchus mykiss*) which occur in Coyote Creek downstream of Anderson Dam and rely on cold water released from the dam for several life stages. To monitor and evaluate the potential impacts to fish and other species as a result of changes to habitat and potentially diminished water quality during construction activities, Valley Water monitoring efforts will evaluate in stream habitat, fish presence and other biological attributes of the system.

Valley Water filed a Final Reservoir Operations and Drawdown Plan (Drawdown Plan) describing the implementation of the February 20, 2020 FERC Order including avoidance and minimization measures. In response to the Drawdown Plan, FERC issued a new Order regarding portions of the Drawdown Plan on October 1, 2020. Ordering paragraph B(10) of the October 1, 2020 Order required VW to develop a Fisheries Monitoring and Adaptive Management plan that defined the goals, and methods to achieve those goals, in regards to monitoring habitat and fisheries in Coyote Creek. The Fisheries Monitoring Plan was merged with the Temperature Monitoring plan (Ordering paragraph B(6) of the October 1, 2020 FERC order) as they are closely related. The combined plan is known as the Water Temperature and Fisheries Monitoring Plan (Plan; Valley Water, 2020). The Plan was developed to comply with the October 1, 2020 FERC order and was reviewed by National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW) and the Unites States Fish and Wildlife Service (USFWS). The Plan provides an approach to monitoring the suitability of conditions in Coyote Creek during the construction of Anderson Dam to help determine if a fish rescue and relocation effort is warranted (outlined in the

Anderson Dam Tunnel Project: Fish Rescue and Relocation Plan Supplement (FERC Ordering Paragraph B(8))) (Stillwater Sciences, 2020).

Section 5.1 of the Water Temperature and Fisheries Monitoring Plan outlines Juvenile *O. mykiss* Rearing, Migration Study and Growth Monitoring as additional studies to be conducted to evaluate the presence, density, movement, survival and growth of *O. mykiss* in the functional cold water management zone (FCWMZ) of Coyote Creek during each year of FOCP activities (2021-2024). To address juvenile rearing in the FCWMZ, multi-pass depletion electrofishing is to be conducted in the fall of each year in specific Index Reaches. Collection of this data will provide information on the occurrence of reproduction and the age classes of *O. mykiss* present in the FCWMZ. Juveniles captured during this effort will be scanned for PIT tags and tagged if they are greater than 65 mm in length and not already tagged. By doing so, juvenile *O. mykiss* can be detected on PIT antenna arrays distributed throughout Coyote Creek to glean information on movement and migration patterns. In addition to movement studies the juvenile rearing monitoring will also allow for a comparison of lengths and any possible changes in the condition of fish in the FCWMZ during FOCP activities. Previously tagged fish can be compared across years and general population trends can be compared across FOCP years.

In addition to the development of the Water Temperature and Fisheries Monitoring Plan, the October 1, 2020 FERC Order required Valley Water to supplement the Fish Rescue and Relocation Plan (ordering paragraph B(8)). The Plan was supplemented and submitted to FERC on November 30, 2020. In consultation with NMFS, USFWS, and CDFW the Plan was further amended and submitted on June 9, 2021. On June 11, 2021, FERC issued the Order Modifying and Approving the Fish Rescue and Relocation Plan. In the Order Modifying and Approving the Fish Rescue and Relocation Plan, Paragraph C required Valley Water to file a Fyke Trap Plan describing how it would PIT tag and gather mark-recapture information on out-migrating juvenile *O. mykiss*. VW consulted with the agencies regarding the Fyke Trap Plan at the August 2020 Technical Working Group. The group discussed the approach and limitations in the

system.. Based on the agency discussion, Valley Water developed a modified method for assessing juvenile outmigration that achieves the goals set forth by the Order Modifying and Approving the Fish Rescue and Relocation Plan. The subsequent Fyke Trap and PIT tag Plan was submitted to NMFS, CDFW, and USFWS for review on July 20, 2021 (Valley Water, 2021(d)). The final Plan, submitted to FERC on September 9, 2021, expands upon the monitoring ordered in in the Water Temperature and Fisheries Monitoring Plan by answering questions related to production and outmigration.

This expanded monitoring will be conducted each year of FOCP activities, (2021 to 2024). The Index Sampling proposed in the Water Temperature and Fisheries Monitoring Plan suggested isolated reaches of 40 m in length be fished with electrofishers using multi-pass depletion techniques as occurred in 2019. The Fyke Trapping and PIT Tag Plan implements a study design of four isolated reaches, 100 meters long. These reaches will serve as Index Reaches and will be resampled in the fall and in the early spring each year of FOCP, through 2024. In addition to the Index Reach sampling the entire FCWMZ of Coyote Creek from Ogier Ponds to Anderson Dam will be sampled each fall and will focus on preferred *O. mykiss* habitat with the goal of catching as many *O. mykiss* as possible to PIT tag or recover from previous tagging efforts.

As these two sampling efforts are similar in timing, techniques and personnel needed, the fall 2021 sampling combined the two efforts and the results from each sampling effort are shared in this document. For ease of understanding the isolated reach sampling will be referred to as “Index Sampling” and the greater sampling effort to re/capture fish between Anderson Dam and Ogier ponds will be referred to as the “Comprehensive Sampling”. Work was conducted under Section 10(a)1(A) Recovery Permit # 16417-2R and California Department of Fish and Wildlife Scientific Collecting Permit S-191480002-21124-001.

# 2. Methods

## 2.1 Study Area

The Coyote Creek Watershed is the largest watershed in Santa Clara County, encompassing over 829 square kilometers. The eastern and southern portions of the watershed drain most of the western face of the Diablo Mountain Range where the creek originates at elevations up to 1,110 meters. These upper watershed areas remain undeveloped with little anthropogenic disturbance. The northern and western portions of the watershed are comprised of the Santa Clara County valley floor. Portions of the valley floor are extensively urbanized with patches of undeveloped parks and open agricultural lands. Coyote Creek has 29 tributaries and flows northwest through the valley, approximately 68 kilometers from the headwaters, where it enters the southern extent of the San Francisco Bay. Two systems in the Coyote Creek Watershed are defined as critical habitat for *O. mykiss*: Coyote Creek and Upper Penitencia Creek. The area of study for this document is the FCWMZ, defined as the portion of Coyote Creek between Ogier Ponds and Leroy Anderson Dam.

## 2.2 Comprehensive Sampling

As referenced in the Fyke Trapping and PIT tag Plan (Valley Water 2021(d)) in 2021 the entire sampleable area of Coyote Creek between Ogier Ponds and Anderson Reservoir was sampled in the fall to develop a complete census of the FCWMZ in Coyote Creek. This comprehensive juvenile rearing sampling will be continued in fall through the duration of the FOCP project, 2021 to 2024. The methods used to sample this region are similar to those used in the 2020 and 2021 fish rescue and relocation effort (Valley Water & Stillwater Sciences 2020, Valley Water 2021(a)). Seven continuous reaches were sampled using electrofishing over the course of three days (Figure 1). Water quality metrics were recorded at the beginning of each reach. Any *O. mykiss* captured of adequate size was tagged and released back into the reach in which it was captured after a period of recovery.

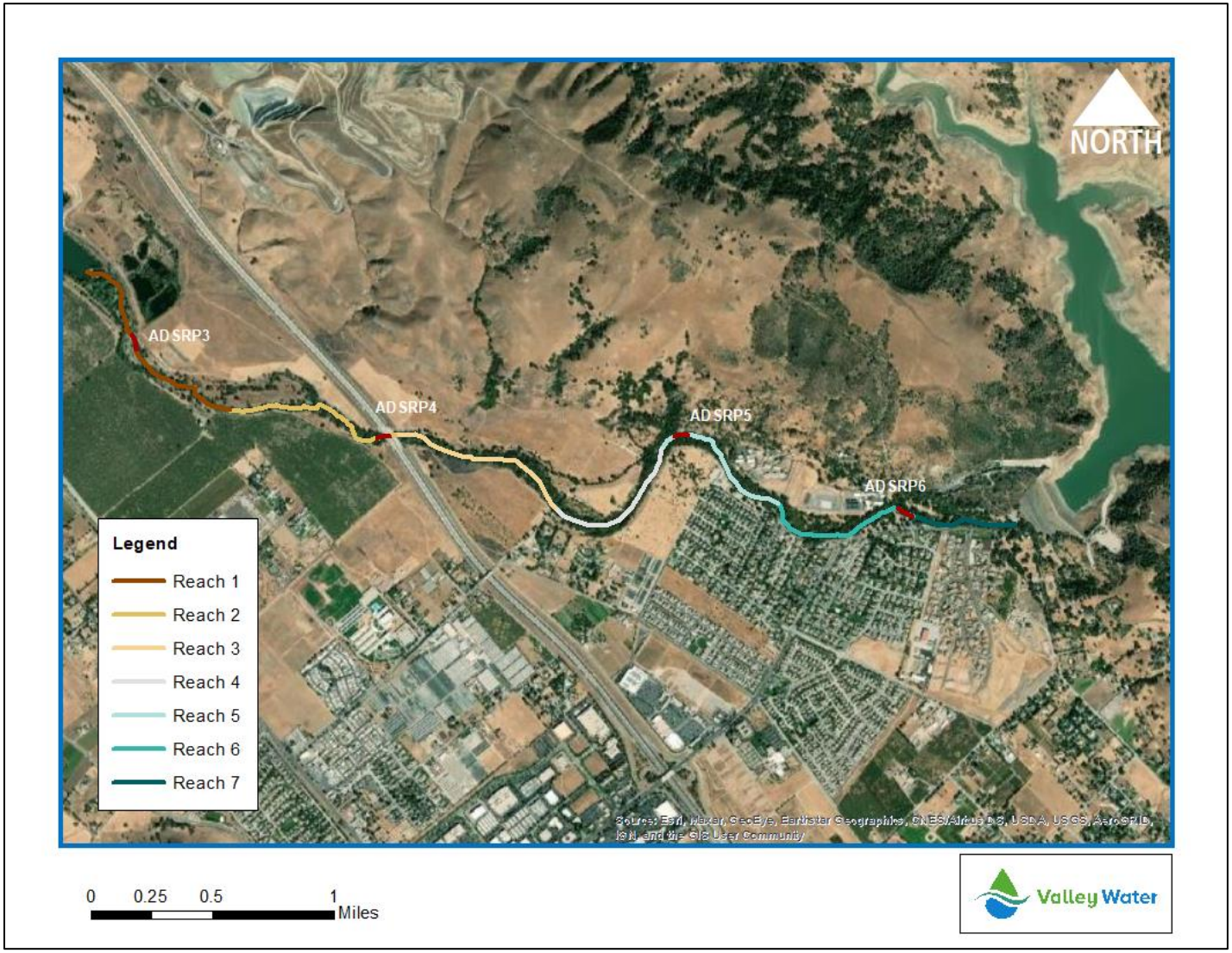


*Figure 1. Seven continuous reaches from Ogier Ponds to Anderson Dam with the Index Reaches embedded (delineated in RED). ADSRP3 falls within Reach 1, ADSRP4 falls within Reach 2, ADSRP5 falls within Reach 5 and ADSRP6 falls within Reach 6. All suitable and accessible habitat was surveyed within the seven consecutive reaches.*

## 2.3 Index Sampling

A subset of the area between Ogier Ponds and Anderson Dam was sampled in isolated reaches (Index Reaches) to help develop production estimates. Four reaches, ranging from 70 to 100 meters in length, were isolated and sampled using multi-pass depletion electrofishing (Figure 1 and Table 1). Reach selection was based on the 2019 sampling effort and expanded upon. These isolated reaches will serve as Index Reaches and will be re-sampled in the fall and early summer beginning after June 15, 2022 (based on Section 10(a)1(A) Recovery Permit # 16417-2R). *O. mykiss* captures from these reaches will be compared across years and to assess production, growth and survival.

Multi-pass depletion backpack electrofishing was deployed at every Index Reach (Johnson et al. 2007). This method allowed for consistency with other juvenile rearing monitoring methods in the County, the extrapolation of population estimates, and the sampling of a variety of habitat types. This is the first year that 100 m reaches have been sampled on Coyote Creek.

*Table 1. Index Reach specifications on Coyote Creek.*

| Index Reach | General Location | Length |
|---|---|---|
| ADSRP3 | Model Airplane Park SCCMAS | 100 meters |
| ADSRP4 | Hwy 101 Crossing | 100 meters |
| ADSRP5 | Downstream of Stream Gage 5082 -Coyote Creek at Madrone | 70 meters |
| ADSRP6 | Downstream of Live Oak Pedestrian Bridge | 85 meters |

## 2.4 Habitat Typing

Each reach sampled during the Index Sampling was habitat typed using the classifications following Ode (2007) (Table 2). Average wetted width and depth were estimated and the presence of any anthropogenic influences (bridge, dam, etc.) was noted. Prior to the start of sampling, ambient weather conditions were recorded and water quality data (dissolved oxygen, conductivity, turbidity, and temperature) was

collected at the downstream end of each reach. Ocular estimates of percent cover of macrophytes/emergent vegetation, boulders, woody debris, undercut banks, overhanging vegetation, submerged roots (live and dead), and artificial structures were recorded for each reach. Each habitat feature was ranked on a 0-4 point scale described in Table 3, with 0 being absent and 4 being a very heavy presence. Primary and secondary substrate types were determined based upon ocular estimates (Table 4; Ode 2007).

*Table 2. Habitat Classifications (Ode 2007)*

| Habitat Type | Description |
|---|---|
| **Cascades** | Short, high gradient drop in streambed elevation often accompanied by boulders and considerable turbulence. |
| **Falls** | High gradient drop in elevation of the streambed associated with an abrupt change in the bedrock. |
| **Rapids** | Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles. |
| **Riffles** | Shallow sections where the water flows over coarse streambed particles that create mild to moderate surface turbulence. |
| **Step-Run** | A series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope. |
| **Runs** | Sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool. |
| **Glides** | A section of stream with little or no turbulence, but faster velocity than pools. |
| **Pool** | A reach of stream that is characterized by deep, low-velocity water and a smooth surface. |

*Table 3. Occular estimates (Ode 2007).*

| Scale | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| **Percent Coverage** | 0% | <10% | 10-40% | 40-75% | >75% |
| **Descriptor** | Absent | Sparse | Moderate | Heavy | Very Heavy |

*Table 4. Substrate classes.*

| Particle Size | Size Category |
|---|---|
| **Boulder** | > 250 mm |
| **Cobble** | 65-250 mm |
| **Gravel** | 2.0-65 mm |
| **Sand** | <2.0 mm (gritty texture) |
| **Silt/Clay** | Not gritty |
| **Bedrock** | No individual particles |

## 2.5 Electrofishing

During the Index Sampling block nets were installed at both the upstream and downstream ends of sampling reaches to block immigration and emigration between the sampling reach and Coyote Creek. Electrofishing commenced from downstream to upstream and worked laterally across the stream to ensure all portions of the wetted width were sampled. Smith-Root LR24 Backpack Electrofishing Units were used at all monitoring reaches. The LR24 quick set option was used to establish the initial power and waveform settings. The quick set output was verified with conductivity readings. Electrofishers were run using direct current, at a frequency of 30 Hz, duty cycle of 12%, and a voltage of 225-240 on Coyote Creek. Each electrofisher operator(s) was flanked by two netters and verbal communication and spatial awareness were used to ensure the entire width of the stream was covered. Triple-pass depletion electrofishing methods were deployed at all index reaches.

During the Comprehensive Sampling the same electrofishing settings and methods were used but no block-nets were deployed. Crews sampled Coyote Creek from downstream to upstream in a continuous fashion, skipping habitats that were unsampleable. If *O. mykiss* were captured, the habitat unit was resampled until no more *O. mykiss* were captured before the team progressed upstream.

## 2.6 Fish Processing

Fish were held in aerated containers during processing. Carbon dioxide ($CO_2$) was administered to *O. mykiss* using Alka-Seltzer Gold in doses to induce light narcosis (1

tablet per 2.5 liters of stream water). *O. mykiss* were exposed to the anesthesia for no more than 5 minutes. *O. mykiss* were observed for listing, and upon listing were removed from the anesthetizing solution, weighed, measured, fin-clipped for a genetic sample, and PIT tagged if large enough (≥65 mm fork-length).

Fish were transferred from anesthesia to a tared measuring board on a scale. Weights were measured to the nearest tenth of a gram. Length measurements were recorded to the nearest millimeter at the fork of the tail (fork-length). For each pass of the Index Reach sampling, up to 30 individuals of each other species were measured, and all other individuals of that species were tallied for a total number. All *O. mykiss* were measured regardless of the number captured.

Fin clips were taken for genetic analysis of all *O. mykiss* from the caudal fin. Clips were a 1-2 mm square. Medical grade scissors used to collect the clips were sterilized with an alcohol dilution with a final concentration of 60-80% isopropyl. Tissue samples were folded into sterile chromatography paper and then placed in a labeled envelope denoting the field specimen number, species, stream, stream location, date, and fork-length. Tissues collected will be sent to the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center for analysis.

All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 1999) by staff trained in the procedure. All *O. mykiss* 65 mm in fork-length or greater received a PIT tag. Biomark single-use preloaded needles were used with the 12 mm tags. A hand loaded syringe style injector was used to inject the 23 mm tags. Prior to inserting PIT tags, all *O. mykiss* were scanned to ensure they were not previously tagged, and all PIT tags were scanned to verify they were viable. *O. mykiss* greater than or equal to 65 mm fork-length received 12 mm half-duplex PIT tags. *O. mykiss* larger than 150 mm fork-length received 23 mm tags. The permits allow for fish greater than 100 mm to be tagged with 23 mm tags, but to be conservative with the fishes' welfare, the minimum size was increased to 150 mm. PIT tag numbers and associated biological data for each fish is included in Appendix A.

After exposure to the anesthesia and all procedures, fish were placed in an aerated receptacle, then transferred to an in-channel live car for recovery before being released into the reach or Index Reach in which they were captured.

## 2.7 Data Analysis

MicroFish 3.0 was used to calculate population estimates for the Index Sampling using a maximum-likelihood iterative process (MLIP); the associated standard errors and 95% confidence intervals (95% CI) are reported. This method uses the number of fish captured (n) and the difference in capture between electrofishing passes (i.e., depletion rate) to calculate an estimate of fish likely to have been present but not captured, thus generating a population estimate (N) for each reach. Population estimates are restricted to the sampled areas and are only an index of the overall population. If the number of a particular species is too low (i.e., only one fish was captured) or all fish of a particular species are captured on the first pass, then a maximum-likelihood population estimate cannot be produced. If the lower confidence interval was less than the total catch it was set equal to total catch, as it is certain at least that many fish were present in the sampling reach. These calculations assume emigration and immigration were prevented by the block nets. It is assumed that shocking efficiency did not change between passes and that staff did not become more efficient using the equipment, nor did fish learn to avoid the electrical field between passes.

A Kruskal Wallis test was used to determine if a difference existed between the June and November mean fork-lengths of O. mykiss sampled. The Kruskal Wallis test was chosen for the varying sample sizes of the two datasets and the fact that neither population had normally distributed values.

# 3. Results

## 3.1 Index Sampling

Index Sampling occurred at four reaches on Coyote Creek on November 1, 2, and 3, 2021 (Figure 1). The weather ranged from light rain on November 1 to sun and clear skies on November 2 and 3. Flows at the stream gage 5082 Coyote Creek at Madrone, were approximately 11-12 cubic feet per second (cfs; flow measurements will be reported using the standard unit system) for the duration of the sampling event.

### ADSRP3

ADSRP3 was the most downstream reach sampled on Coyote Creek. A band of riparian vegetation is present and varies between thick, tall willow stands and shorter riparian vegetation (Figure 2). The channel is situated across from the Santa Clara County Model Airplane Society (SCCMAS) model airplane park. The reach was 100 m in length with an average wetted width of 6.0 m and an average depth of 0.3 m. Three habitat types were present within the reach: riffle, run and pool.

The riffle habitat made up 75% of the habitat sampled, with the run habitat contributing to 20% and the pool contributing 5% to the habitat sampled. The primary substrate was cobble with a secondary substrate of gravel. Water quality and habitat complexity at the time of sampling are summarized in Table 5.

*Figure 2. Photos of ADSRP3, looking upstream (left) and looking downstream (right).*

*Table 5. Coyote Creek ADSRP water quality data and ocular estimates of habitat complexity.*

| Water Quality | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/l)** | **Turbidity (NTU)** |
| 627.00 | 15.76 | 8.43 | 25.00 |

| Habitat Complexity Scoring | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 2 | 1 | 1 | 0 | 1 | 1 | 0 |

Fish captured and associated population estimates are summarized in Table 6. Seven species of fish were captured: prickly sculpin (*Cottus asper*), mosquitofish (*Gambusia affinis*), largemouth bass (*Micropterus salmoides*), Sacramento sucker (*Catostomus occidentalis*), Tule perch (*Hysterocarpus traskii*), hitch (*Lavinia excilicauda*) and *O. mykiss*. Of the seven species captured at ADSRP3 five were native (hitch, Sacramento sucker, prickly sculpin, tule perch and *O. mykiss*) and two were non-native (largemouth bass and mosquito fish) (Table 6). The most abundant species was prickly sculpin (n=107). The MLIP indicates that the number of prickly sculpin was likely higher than what was observed. The density of *O. mykiss* in this reach was observed at 0.02 *O. mykiss* per meter (*O. mykiss*/m). The *O. mykiss* captured measured 209 mm and 151 mm fork-length.

*Table 6. Number captured and population estimates at ADSRP3.*

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| Hitch | Yes | 1 | 1 | 2.027 | 1-1 |
| Largemouth bass | No | 2 | 2 | 0.384 | 2-7 |
| Mosquito fish | No | 1 | 1 | 0.734 | 1-1 |
| Prickly sculpin | Yes | 107 | 115 | 4.896 | 107-125 |
| *O. mykiss* | Yes | 2 | 2 | 1.038 | 2-15 |
| Sacramento sucker | Yes | 14 | 14 | 0.818 | 14-16 |
| Tule Perch | Yes | 1 | 1 | 0 | 1-1 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

*Figure 3. O. mykiss captured in reach ADSRP3.*

ADSRP4

The upstream extent of ADSRP4 was located under Highway 101. The reach is bordered by the Coyote Creek Trail, with rural parks and orchards. A dense riparian area is present downstream of Highway 101. The reach was 100.0 m in length with an average wetted width of 10.0 m and an average depth of 0.1 m. Three habitat types were present in the reach; riffle, run and glide. Habitat within the reach was 45% riffle and 45% run and 10% glide (Figure 4). The primary substrate was gravel, with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 7.

*Figure 4. Photos of ADSRP4, looking upstream (left) and looking downstream (right).*

*Table 7. Coyote Creek ADSRP4 water quality data and ocular estimates of habitat complexity.*

| **Water Quality** | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/l)** | **Turbidity (NTU)** |
| 584.00 | 16.14 | 6.27 | 21.2 |

| **Habitat Complexity Scoring** | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 1 | 1 | 0 | 1 | 3 | 1 | 0 |

Six species of fish were captured at ADSRP4: Sacramento sucker, *O. mykiss*, tule perch, southern coastal California (SCC) roach (*Hesperoleucus venustus subditus)*, prickly sculpin and hitch. Fish captured and associated population estimates are summarized in Table 8. The most abundant species captured was prickly sculpin. The MLIP indicated that there were likely more prickly sculpin in the reach than were captured. The density of *O. mykiss* in this reach was observed at 0.04 *O. mykiss* per meter (*O. mykiss*/m). The *O. mykiss* captured measured 126 mm, 101 mm, 99 mm and 97 mm fork-length.

*Table 8. Number captured and population estimates at ADSRP4 on Coyote Creek.*

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| SCC roach | Yes | 1 | 1 | 0 | 1-1 |
| Hitch | Yes | 4 | 4 | 0.544 | 4-6 |
| Prickly sculpin | Yes | 36 | 37 | 1.653 | 36-40 |
| *O. mykiss* | Yes | 4 | 4 | 0.969 | 4-7 |
| Sacramento sucker | Yes | 14 | 14 | 0.633 | 14-15 |
| Tule Perch | Yes | 2 | 2 | 1 | 2-15 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

ADSRP5

ADSRP5 is upstream of Coyote Canal Diversion on Santa Clara County Parks Property. The surrounding land cover is riparian vegetation within Anderson Lake County Park to one side and rural park lands to the other side. The reach was 70.0 m in length with an average wetted width of 8.0 m and an average depth of 0.25 m. The reach consisted of riffle and run habitat (Figure 5). The riffle habitat comprised 79% of the reach and the run habitat comprised the remaining 21%. The primary substrate was cobble with a secondary substrate of silt. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 9.

*Figure 5. Photos of ADSRP5, looking upstream (left) and looking downstream (right).*

*Table 9. Coyote Creek ADSRP5 water quality data and ocular estimates of habitat complexity.*

| Water Quality | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/l)** | **Turbidity (NTU)** |
| 589.00 | 17.25 | 5.84 | 44.5 |

| Habitat Complexity Scoring | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 1 | 1 | 2 | 0 | 2 | 1 | 0 |

The three species of fish captured were hitch, prickly sculpin, and *O. mykiss*. The most abundant species encountered was hitch (n=24). Fish captured and associated population estimates are summarized in Table 10. The MLIP indicates that hitch numbers were likely higher than what was observed. The density of *O. mykiss* was observed at 0.1 *O. mykiss* per meter (*O. mykiss*/m). The *O. mykiss* captured measured 139 mm, 129 mm, and 132 mm, 115 mm, 129 mm, 124 mm, and 119 mm fork-length.

*Table 10. Number captured and population estimates at ADSRP5 on Coyote Creek.*

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| Hitch | Yes | 24 | 36 | 0 | 36-36 |
| Prickly sculpin | Yes | 9 | 9 | 0.461 | 9-10 |
| *O. mykiss* | Yes | 7 | 7 | 0.327 | 7-8 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

*Figure 6. O. mykiss from ADSRP5.*

ADSRP6

ADSRP6 is just downstream of the Live Oak pedestrian bridge on Santa Clara County Parks property. The surrounding land use is manicured park land with lawn and picnic tables to one side and rural parks lands to the other. The monitoring reach was 85.0 m in length with an average wetted width of 9.0 m and an average depth of 0.3 m. The reach consisted of riffle and pool habitat (Figure 7). The primary substrate was cobble with a secondary substrate of boulders. Riffle habitat made up 72% and pool habitat made up the remaining 28%. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 11.

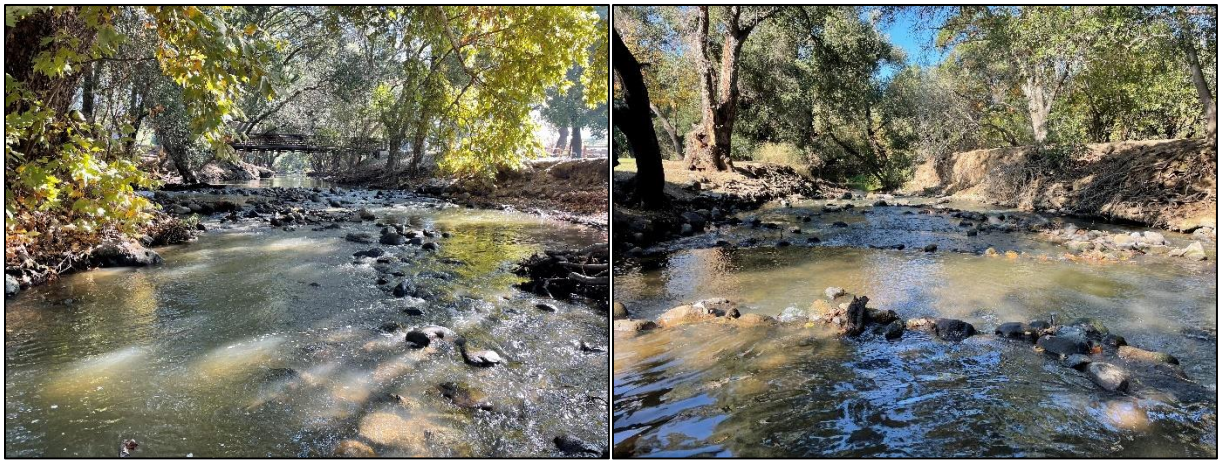

*Figure 7. Photos of ADSRP6, looking upstream (left) and looking downstream (right).*

*Table 11. Coyote Creek ADSRP6 water quality data and ocular estimates of habitat complexity. The dissolved oxygen meter experienced an error and no DO was recorded at this site.*

| **Water Quality** | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/l)** | **Turbidity (NTU)** |
| 612.00 | 17.11 | - | 28.0 |

| **Habitat Complexity Scoring** | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 1 | 4 | 1 | 2 | 3 | 2 | 0 |

Seven species of fish captured were: *O. mykiss*, Sacramento sucker, prickly sculpin, largemouth bass, hitch, bluegill (*Lepomis macrochirus*) and inland silverside (*Menidia beryllina*). The most abundant species encountered was hitch (n=73). Fish captured and associated population estimates are summarized in Table 12. The MLIP indicates that the number of bluegill, hitch and inland silversides present in the reach is likely higher than what was captured. The density of *O. mykiss* in this reach was observed at 0.02 *O. mykiss* per meter (*O. mykiss*/m). The *O. mykiss* captured measured 131 mm, and 140 mm fork-length.

*Table 12. Number captured and population estimates at ADSRP6 on Coyote Creek.*

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| Bluegill | No | 3 | 5 | 9.677 | 3-32 |
| Hitch | Yes | 73 | 85 | 7.869 | 73-101 |
| Inland silverside | No | 4 | 6 | 0 | 6-6 |
| Largemouth bass | No | 1 | 1 | 0 | 1-1 |
| Prickly sculpin | Yes | 24 | 24 | 1.177 | 24-26 |
| *O. mykiss* | Yes | 2 | 2 | 0 | 2-2 |
| Sacramento sucker | Yes | 5 | 5 | 0 | 5-5 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

## 3.2 Index Reach Sampling Summary

The average size of *O. mykiss* caught in the Index Reaches was 129.4 mm. The size distribution can be seen in Figure 8. The density of fish captured/meter indicated that ADSRP5 had the highest density of *O. mykiss*/meter while ADSRP2 and ADSRP6 had the least (Figure 10).

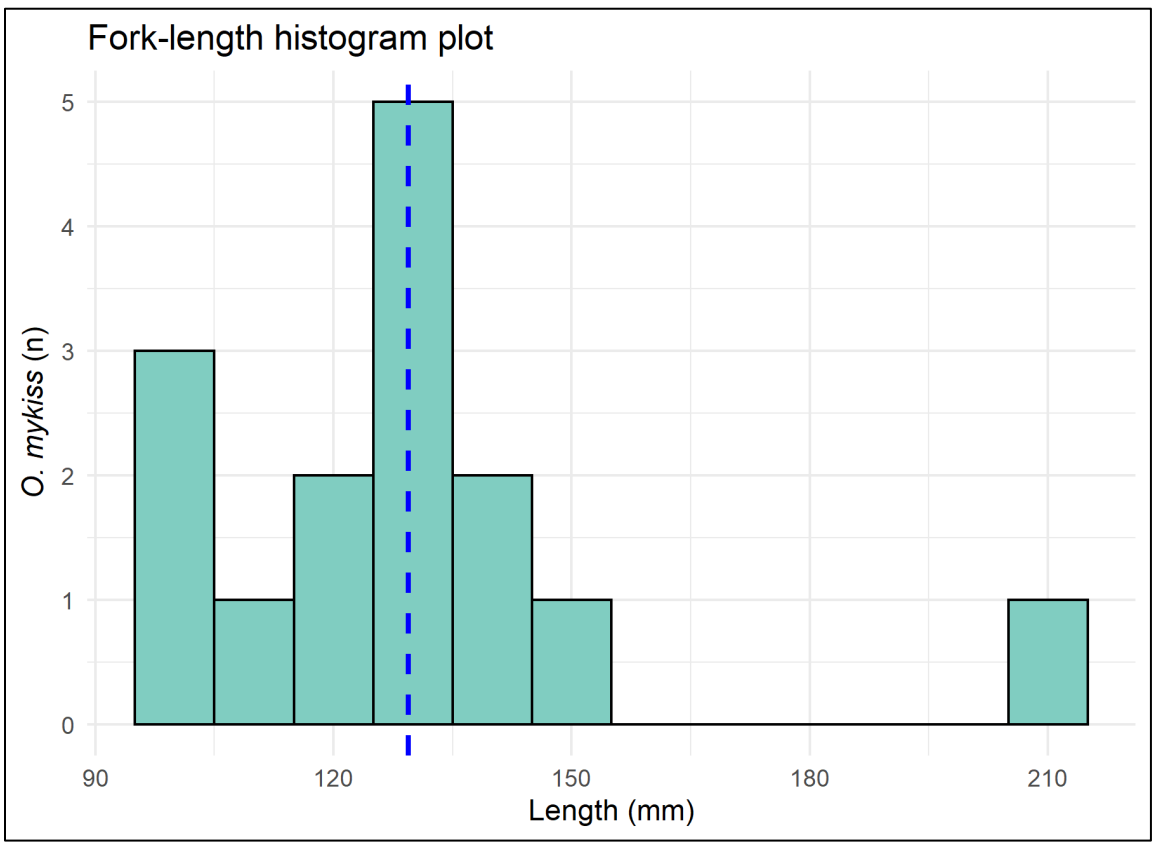


*Figure 8. Histogram of Fork-lengths for all O. mykiss captured in the index reaches (10 mm bins). The blue line represents the mean fork-length (129.4 mm).*

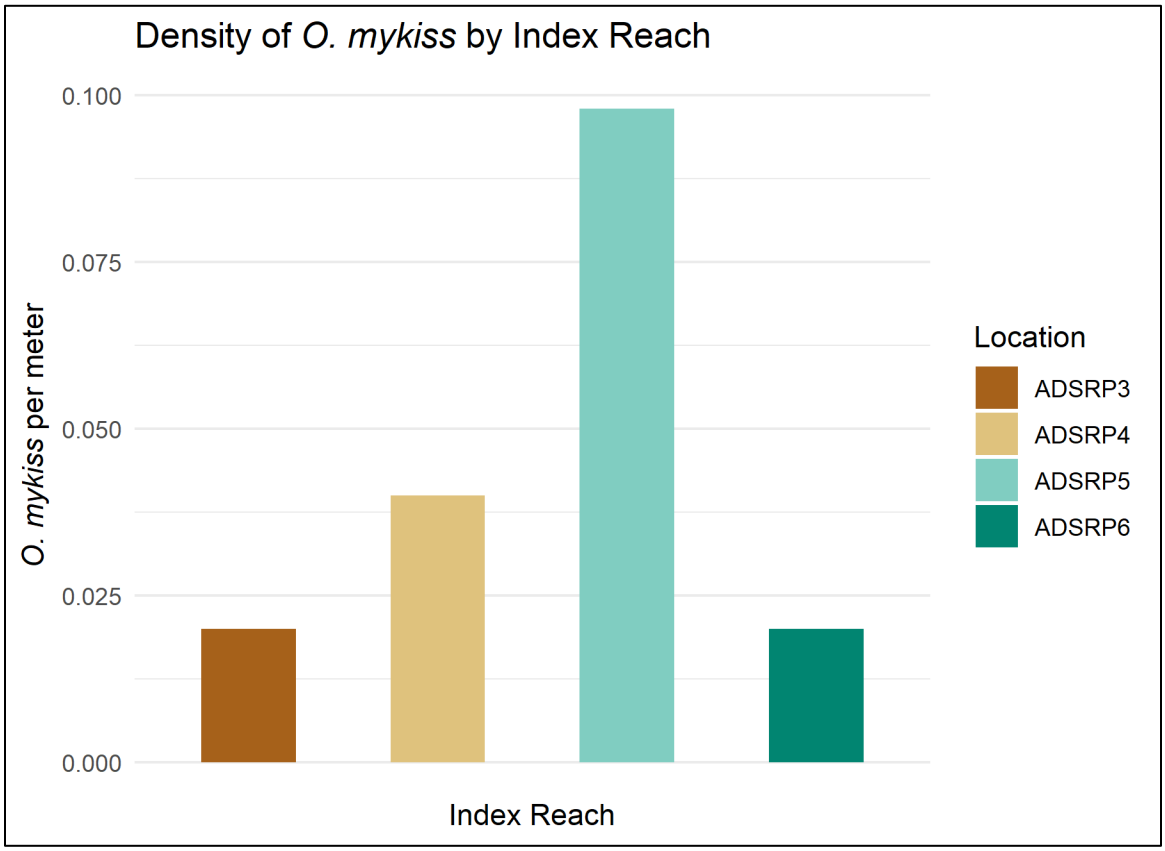


*Figure 9. A comparison of the density of O. mykiss captured by Index Reach.*

## 3.3 Comprehensive Sampling

Comprehensive sampling results for the 2021 Juvenile Rearing Monitoring include both the Index Reach sampling as well as the comprehensive sampling of Coyote Creek. Sampling occurred from November 1 to November 3, 2021. The weather ranged from light rain on November 1 to sun and clear skies on November 2 and 3. Flows at the stream gage 5082 Coyote Creek at Madrone, were approximately 11-12 cubic feet per second for the duration of the sampling event. A total of 945 individual fish were captured during the comprehensive sampling effort including those captured in the index reaches. The following native fish were captured during the combined comprehensive sampling sampling: SCC roach, hitch, Sacramento sucker, prickly sculpin, tule perch and *O. mykiss*. Non-native largemouth bass, spotted bass (*Micropterus punctulatus*), threadfin shad (*Dorostoma petenense*), bluegill, inland

silverside and, mosquito fish were also encountered. Out of the overall total, only 70 (7%) of those fish were non-native fish species (Table 13).

*Table 13. All species captured during the 2021 Coyote Creek Juvenile Rearing Monitoring (Index and Comprehensive sampling combined).*

| Species | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Total |
|---|---|---|---|---|---|---|---|---|
| **1-Nov-21** | | | | | | | | |
| *O. mykiss* | 2 | 4 | 1 | - | - | - | - | 7 |
| Bluegill | 1 | 0 | 0 | - | - | - | - | 1 |
| SCC roach | 0 | 3 | 0 | - | - | - | - | 3 |
| Hitch | 1 | 4 | 0 | - | - | - | - | 5 |
| Inland Silverside | 4 | 0 | 1 | - | - | - | - | 5 |
| Largemouth bass | 3 | 0 | 0 | - | - | - | - | 3 |
| Mosquito fish | 2 | 0 | 0 | - | - | - | - | 2 |
| Prickly sculpin | 160 | 91 | 18 | - | - | - | - | 269 |
| Sacramento sucker | 7 | 21 | 2 | - | - | - | - | 30 |
| Tule perch | 6 | 3 | 0 | - | - | - | - | 9 |
| Total | 186 | 126 | 22 | - | - | - | - | 334 |
| **2-Nov-21** | | | | | | | | |
| *O. mykiss* | - | 0 | 0 | 9 | 9 | - | - | 18 |
| Bluegill | - | 0 | 0 | 0 | 3 | - | - | 3 |
| SCC roach | - | 0 | 0 | 1 | 0 | - | - | 1 |
| Hitch | - | 1 | 0 | 24 | 2 | - | - | 27 |
| Largemouth bass | - | 0 | 1 | 1 | 2 | - | - | 4 |
| Prickly sculpin | - | 38 | 17 | 16 | 7 | - | - | 78 |
| Sacramento sucker | - | 5 | 1 | 0 | 1 | - | - | 7 |
| Tule perch | - | 0 | 0 | 1 | 0 | - | - | 1 |
| Total | - | 44 | 19 | 59 | 17 | 0 | 0 | 139 |
| **3-Nov-21** | | | | | | | | |
| *O. mykiss* | - | - | - | - | 5 | 11 | 8 | 24 |
| Bluegill | - | - | - | - | 2 | 6 | 10 | 18 |
| SCC roach | - | - | - | - | 0 | 6 | - | 6 |
| Hitch | - | - | - | - | 5 | 138 | 112 | 255 |
| Inland Silverside | - | - | - | - | 0 | 4 | 1 | 5 |
| Largemouth bass | - | - | - | - | 1 | 3 | 22 | 26 |
| Prickly sculpin | - | - | - | - | 3 | 32 | 5 | 40 |
| Sacramento sucker | - | - | - | - | 7 | 28 | 60 | 95 |
| Spotted bass | - | - | - | - | - | - | 1 | 1 |
| Threadfin shad | - | - | - | - | - | - | 2 | 2 |
| Total | - | - | - | - | 23 | 228 | 221 | 472 |
| **Grand Total** | **186** | **170** | **41** | **59** | **40** | **228** | **221** | **945** |

Forty-nine *O. mykiss* were captured during the juvenile rearing sampling effort in fall 2021 (comprehensive and index reach sampling combined). *O. mykiss* ranging in size from 80 mm to 380 mm with an average fork-length of 133.1 mm (Figure 10).

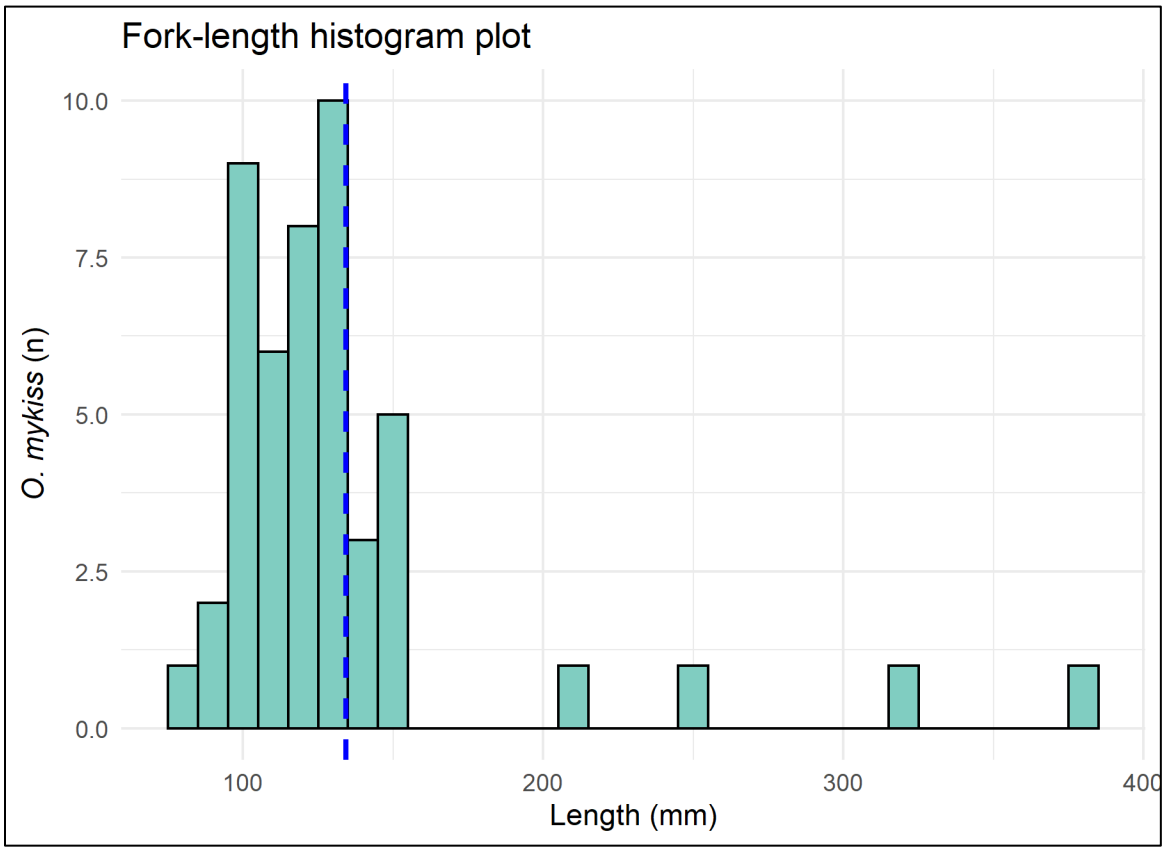


*Figure 10. Fork length histogram for all O. mykiss captured during the Fall 2021 effort including both Index Reach and Comprehensive sampling (10 mm bins). The blue line represents the mean fork-length for fish captured in Coyote Creek. Mean fork-length = 133.1 mm. Fish classified into 10 mm bins.*

# 4. Discussion

The goals of the combined Index and Comprehensive juvenile rearing monitoring during the fall of 2021 were to gain a better understanding of juvenile production, growth and survival in Coyote Creek during summer months as well as capture individuals to tag and then glean information on movement and migration patterns throughout the year. Six native species were detected during this effort: Hitch, SCC roach, prickly sculpin, Sacramento sucker, tule perch and *O. mykiss*. An additional six non-native species were observed: Inland silverside, mosquito fish, largemouth bass, spotted bass, bluegill and threadfin shad.

During the three-day juvenile rearing sampling a total of 945 fish were captured. Of the captures only 70 individuals were not native to the watershed and of those non-natives, 56 were known predators to *O. mykiss* (bluegill, spotted bass and largemouth bass). The highest density of non-native (n=36) and predatory (n=33) fish occurred in Reach 7, closest to the outlet of the reservoir. Crews sampled the concrete apron below the Anderson Dam outlet and found high numbers of non-native species. Reach 6 and Reach 5 had the second highest numbers of predatory non-native species respectively. Reach 1, upstream of Ogier Ponds had the third highest number of non-natives (n=10) and the fourth highest number of predatory non-native species.

*Table 14. Captures of predatory, non-native fish in the FCWMZ reaches of Coyote Creek.*

| Species | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 | Reach 7 | Total |
|---|---|---|---|---|---|---|---|---|
| **1-Nov-21** | | | | | | | | |
| Bluegill | 1 | 0 | 0 | - | - | - | - | 1 |
| Largemouth bass | 3 | 0 | 0 | - | - | - | - | 3 |
| Total | 4 | 0 | 0 | - | - | - | - | 4 |
| **2-Nov-21** | | | | | | | | |
| Largemouth bass | - | 0 | 1 | 1 | 2 | - | - | 4 |
| Bluegill | - | 0 | 0 | 0 | 3 | - | - | 3 |
| Total | - | 0 | 1 | 1 | 5 | 0 | 0 | 7 |
| **3-Nov-21** | | | | | | | | |
| Largemouth bass | - | - | - | - | 1 | 3 | 22 | 26 |
| Bluegill | - | - | - | - | 2 | 6 | 10 | 18 |
| Spotted bass | - | - | - | - | - | - | 1 | 1 |
| Total | - | - | - | - | 3 | 9 | 33 | 45 |
| **Grand Total** | **4** | **0** | **1** | **1** | **8** | **9** | **33** | **56** |

Forty-nine *O. mykiss* were captured during the juvenile rearing effort. *O. mykiss* were present in every reach and at every Index Reach sampled. Based on the sampling effort, it can be concluded that *O. mykiss* are present throughout the FCWMZ, though abundance is varied. In addition to the sampleable habitat on Coyote Creek, deep mid-channel pools and glides that were not wadeable were also present. These habitats

were not sampled. It is likely that the number of *O. mykiss* residing in Coyote Creek is higher than sampling indicated due to these areas not being sampled.

The highest number of *O. mykiss* were captured in Reach 5, n=14. In general, the reaches closest to the Dam had higher numbers than those closer to Ogier ponds (Figure 11).

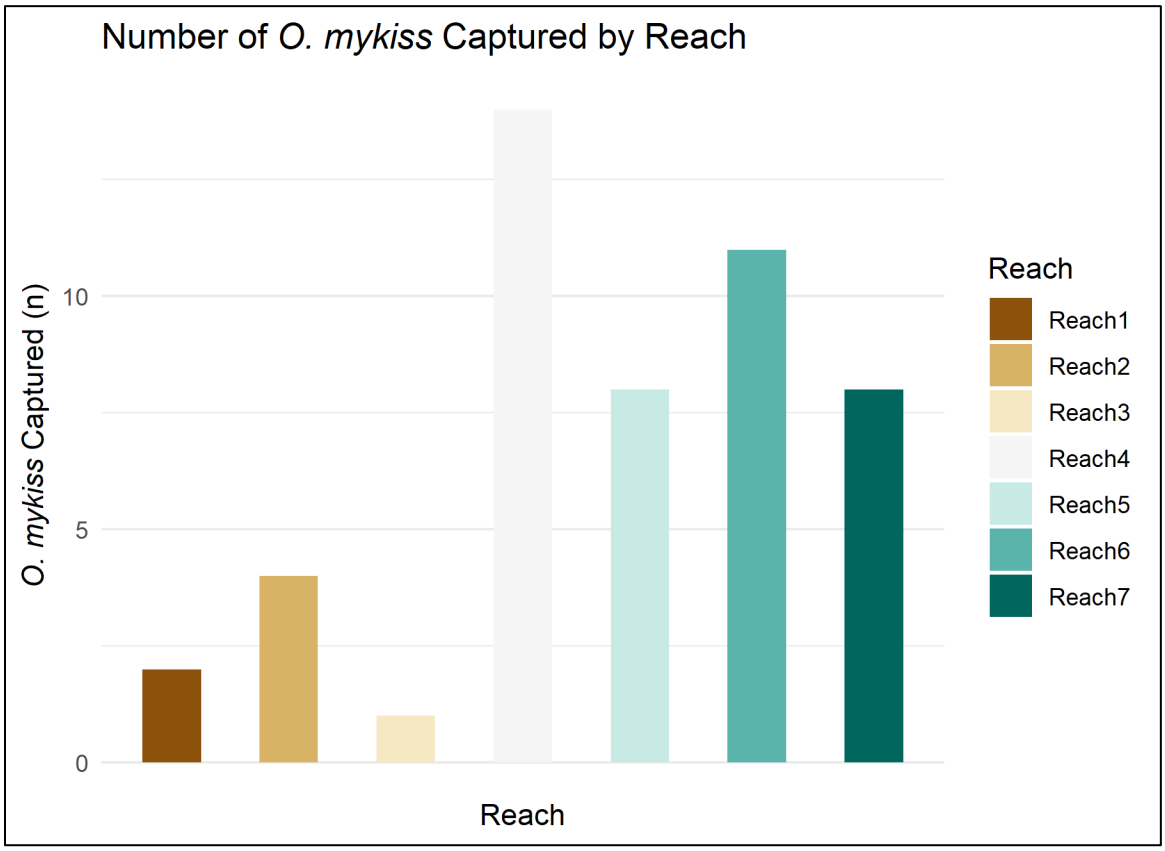


*Figure 11. Observed O. mykiss captured at the seven reaches of Coyote Creek between Ogier Ponds and Leroy Anderson Dam in 2021 including the nested Index reaches. Forty-nine fish were captured during this effort.*

The density of *O. mykiss* in the Index Reaches was highest at ADSRP5 (.1 *O. mykiss*/meter), followed by ADSRP4 (Figure 10). Paired with the captures/reach information from the comprehensive sampling (Figure 11) these numbers suggest that *O. mykiss* presence is highest in the mid-reaches of the FCWMZ.

*O. mykiss* ranged from 80 mm to 380 mm with a mean fork-length of 133 mm. According to Smith (2021), *O. mykiss* in Coyote Creek with fork-lengths up to 175 mm

were young-of-the-year (YOY). The majority of the fish captured in November fall into this range (n= 45). The four, remaining fish with fork-lengths of 250-380 mm were likely yearlings and possibly two-year olds (Smith, personal communications 11/19/2021). *O. mykiss* captured on Coyote Creek during the June Fish Rescue and Relocation for FOCP ranged from 59 mm to 515 mm with a mean fork-length of 115 mm. It is estimated that the fish captured in the June rescue and relocation effort with fork-lengths of 150 or less were YOY indicating that successful reproduction had taken place earlier in the year. Individuals caught in June with fork-lengths between 225 and 250 were likely yearlings and the small number of fish greater than 250 were likely two-year old fish. As with the fall sampling the majority of the fish captured were less than or equal to 151 mm (n = 142). Due to the similarity in methods between the fish rescue effort in June and the juvenile rearing sampling in November 2021 the fork-lengths between the two temporal populations were compared (Figure 12). During the summer fish rescue 158 *O. mykiss* were captured and 47 of those captured fish were relocated to lower Coyote Creek. These fish were removed from the analysis as they were not available to be recaptured in the fall for comparison. The increase in average fork-length from 87 mm (June) to 133 mm (November) indicates that growth occurred over the summer months.

Using a Kruskal-Wallis test there appears to be a significant difference between the two seasonal means [H = 79.35, df = 1, P = < 2.2e-16].

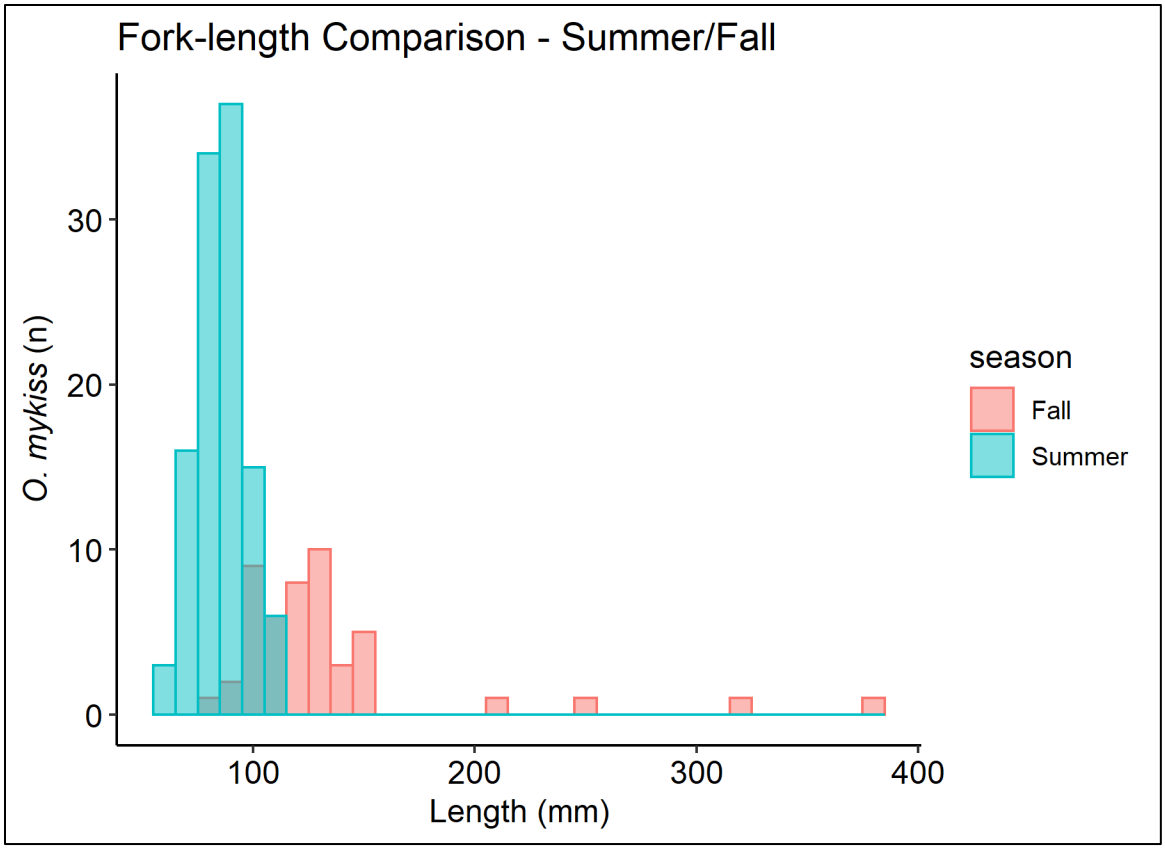


*Figure 12. A comparison of fork-length between the summer sampling and fall sampling. Fewer fish were captured in November than June, but the average size increased from 87 mm to 133mm.*

All *O. mykiss* captured during the juvenile rearing effort were PIT tagged. Forty-two received a 12mm tag and seven received a 23mm tag (Table 14, Appendix A). One fish from Reach 4 received a 12 mm PIT tag but a software error caused the tag number to not be recorded. These tagged fish can now be detected at any of the three stationary PIT tag arrays in Coyote Creek.

*Table 15. PIT tags implanted in Coyote Creek O. mykiss by size.*

| Reach | 12mm Tag | 23mm Tag |
|---|---|---|
| **Reach 1** | 0 | 2 |
| **Reach 2** | 4 | 0 |
| **Reach 3** | 1 | 0 |
| **Reach 4** | 9 | 0 |
| **Reach 5** | 14 | 0 |
| **Reach 6** | 10 | 1 |
| **Reach 7** | 4 | 4 |
| **Total** | 42 | 7 |

The juvenile rearing effort and fish rescue and relocation efforts in 2021 provided valuable information on the Coyote Creek *O. mykiss* population. The presence of 111 *O. mykiss* with fork-lengths of 100 mm or less in June indicated that successful spawning had occurred and the subsequent capture of 49 individuals in November demonstrated that summer rearing in the FCWMZ was possible during summer months when stream temperatures were high and flows were reduced due to the extreme to exceptional drought conditions and FOCP project. The maximum weekly average temperature (MWAT) during the summer rearing period ranged from 22.06°C to 23.58°C within the FCWMZ (Valley Water 2021(b)) with peak temperatures occurring in August of 2021. The fall juvenile rearing sampling was conducted after the warmest portion of the season and indicates the status of the population after these stressful conditions. The November sampling captured individuals from multiple age classes in Coyote Creek from young of the year to at least two-year old indicating that summer habitat and prey availability in Coyote Creek is capable of supporting rearing, and multiple age classes even with the increased metabolic demand associated with warmer stream temperatures (Myrick and Cech 2005). A fish condition analysis found the fish captured in November to be in overall good condition (Appendix B; Valley Water 2021(c)). This is encouraging news in light of the extreme drought conditions in Santa Clara County during the summer of 2021. In addition to the above average condition of

the fish, no black-spot (*Neascus*-type parasitic infection, caused by digenean trematodes in the families Diplostomatidae and Heterophyidae.) or other fish pathogens were observed.

This is the first year in which over three *O. mykiss* within the FCWMZ of Coyote Creek have been tagged. As such, in future efforts an additional goal will be to recover previously tagged individuals to glean additional information on annual growth rates and survival. Additionally, the PIT tags implanted will help illuminate trends of movement and potential migration throughout the year and continued in-stream monitoring will lead to a more robust dataset and a better understanding of juvenile production, growth and survival in Coyote Creek. The results of the 2021 sampling indicate that the Coyote Creek *O. mykiss* are a resilient and adaptable population of individuals who have weathered the changing conditions due FOCP activities and severe drought. More information will become available as monitoring efforts continue into the future.

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# Appendix A

# PIT Tag List

| Date | Creek | Species | Weight (g) | Length (mm) | PIT ID (Decimal) |
|---|---|---|---|---|---|
| 11/1/2021 | Coyote Creek | *O. mykiss* | 117.9 | 209 | 900.228000613753 |
| 11/1/2021 | Coyote Creek | *O. mykiss* | 43.4 | 151 | 900.228000613754 |
| 11/1/2021 | Coyote Creek | *O. mykiss* | 25.2 | 126 | 982.126059706573 |
| 11/1/2021 | Coyote Creek | *O. mykiss* | 11.9 | 101 | 982.126059706540 |
| 11/1/2021 | Coyote Creek | *O. mykiss* | 13.7 | 99 | 982.126059706520 |
| 11/1/2021 | Coyote Creek | *O. mykiss* | 11.4 | 97 | 982.126059706563 |
| 11/1/2021 | Coyote Creek | *O. mykiss* | 8.9 | 86 | 982.126059709085 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 30.4 | 139 | 982.126059706568 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 24.2 | 129 | 982.126059709100 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 28.7 | 132 | 982.126059706511 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 17.5 | 115 | 982.126059706557 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 26.9 | 129 | 982.126059709087 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 26.7 | 124 | 982.126059706516 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 21.7 | 119 | 982.126059706567 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 9.3 | 95 | 982.126059706513 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 5.2 | 80 | 982.126059706555 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 21.1 | 119 | 982.126059706569 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 12.7 | 97 | Not recorded |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 12.8 | 98 | 982.126059706538 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 16.3 | 105 | 982.126059706550 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 21.4 | 118 | 982.126059709095 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 19.8 | 110 | 982.126059706560 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 27.1 | 125 | 982.126059709089 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 18.5 | 113 | 982.126059709083 |
| 11/2/2021 | Coyote Creek | *O. mykiss* | 23.1 | 125 | 982.126059709096 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 28.4 | 131 | 982.126059706537 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 34.2 | 140 | 982.126059709094 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 14.8 | 104 | 982.126059706526 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 19.6 | 115 | 982.126059706566 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 36.9 | 147 | 982.126059709106 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 32.5 | 141 | 982.126059706564 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 17.5 | 116 | 982.126059706519 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 11.9 | 99 | 982.126059706562 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 37.8 | 148 | 982.126059706545 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 28.0 | 134 | 982.126059709084 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 15.4 | 103 | 982.126059706572 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 17.3 | 112 | 982.126059709098 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 28.4 | 132 | 982.126059709093 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 29.5 | 135 | 982.126059706547 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 43.7 | 150 | 900.228000613813 |

| | | | | | |
|---|---|---|---|---|---|
| 11/3/2021 | Coyote Creek | *O. mykiss* | 23.6 | 126 | 982.126059709086 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 21.2 | 117 | 982.126059706528 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 689 | 380 | 900.228000613812 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 19.9 | 114 | 982.126059706515 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | - | 151 | 900.228000613814 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 418 | 320 | 900.228000613816 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 26.7 | 127 | 982.126059706534 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 132.3 | 252 | 900.228000613815 |
| 11/3/2021 | Coyote Creek | *O. mykiss* | 14.0 | 104 | 982.126059706574 |

# Appendix B

# 2021 Coyote Watershed Central California Coast Steelhead (*Oncorhynchus mykiss*) Condition Analysis

# 2021 Coyote Watershed Central California Coast Steelhead (*Onchorhynchus mykiss*) Condition Analysis


Prepared By:

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January 2021

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# Appendices

Appendix A: Individual Measurements, Standard Weights ($W_s$), and Relative Weights ($W_r$) of *O. mykiss* Sampled During Fall 2021 Coyote Creek Juvenile Rearing Monitoring

# Introduction

The Coyote Creek Watershed is the largest watershed in Santa Clara County, encompassing over 830 square kilometers. The eastern and southern portions of the watershed drain most of the western face of the Diablo Mountain Range where the creek originates at elevations over 900 meters. These upper watershed areas remain undeveloped with little anthropogenic disturbance and consists primarily of mixed forest land. The northern and western portions of the watershed are comprised of the Santa Clara County valley floor. Portions of the valley floor are extensively urbanized with patches of undeveloped parks and open agricultural lands. Coyote Creek flows approximately 68 kilometers from the headwaters northwest through the valley and terminates at the southern extent of the San Francisco Bay.

The Coyote Creek Watershed supports the federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS). Two systems in the Coyote Creek Watershed are designated as critical habitat for *O. mykiss*: Coyote Creek and Upper Penitencia Creek. Coyote Creek critical habitat extends from the creek's confluence with San Francisco Bay to the base of the Leroy Anderson Dam, and Upper Penitencia Creek critical habitat extends from the creek's confluence with Coyote Creek to the base of the dam at Cherry Flat Reservoir; this designation further extends from the confluence of Upper Penitencia Creek upstream to an impassible natural waterfall on Arroyo Aguague Creek.

In 2021, Valley Water conducted index reach monitoring for juvenile *O. mykiss* in mainstem Coyote and Upper Penitencia Creeks. To better understand the health of juvenile *O. mykiss* in this system, fish condition was analyzed for individuals sampled during the 2021 monitoring effort. The relative weight approach was used to evaluate fish condition due to the utility and ease with which it can be calculated and analyzed. No juvenile *O. mykiss* were encountered or captured during the 2021 sampling effort on Upper Penitencia Creek and as such there is no data to report this year.

## Background

Fish condition can be determined based on a measure of length and weight that represents the physiological or nutritional state of a fish. This analysis can be used to compare the effects of biotic and abiotic factors on the health of a population (Murphy et al. 1990, Cone 1989). For instance, the presence of generally plump fish may be indicative of favorable environmental conditions (high-quality habitat, ample prey availability, etc.), whereas thin fish may indicate less favorable conditions. Therefore, monitoring fish condition can be useful for informing management recommendations concerning fish populations.

Relationships between weight and length are often used for assessing population size structure and individual fish condition. Because fish weight is directly related to fish length, weight-length data is not only used to predict one from the other, but it can also be used as an indicator of an individual's overall health or condition by measuring the variation from the expected weight for a certain length (LeCren 1951). The traditional approach to assessing fish condition involves the use of a 'condition factor,' which employs a fixed ratio to describe the relationship between fish length and weight (Murphy et al. 1991). The commonly used Fulton's condition factor ($K$) (Fulton 1904) is calculated as:

$$K = W / L^3$$

Where $W$ is weight and $L$ is length. Though it has the advantage of being easy to calculate, Fulton's condition factor has its drawbacks. First, it assumes isometric growth (power = 3, fish shape does not change with growth), which is rarely the case for most fish species (Froese 2006). Second, it is highly length- and species-dependent; therefore, it can only be reliably used to compare individuals with similar lengths and is practically impossible to compare across species. LeCren (1951) developed the relative condition factor ($K_n$) to address these issues, which is calculated with the formula:

$$K_n = W / W' \times 100$$

Where $W$ is the actual weight of the individual fish and $W'$ is the predicted length-specific mean weight for the population under study. While this approach solved the

problem of comparing fish of different lengths and species, it is population-dependent and thus cannot be used to compare fish condition across populations.

The concept of ‘relative weight’ as a condition index was first introduced by Wege and Anderson (1978) for measuring the condition of largemouth bass (*Micropterus salmoides*). The relative weight approach compares fish weight to a benchmark, or standard weight, of that species based on weight-length data collected throughout its range. Wege and Anderson believed that relative weight had several advantages over other condition factors: 1) it is easy to calculate, 2) relative weight does not change with different units of measure, 3) standard weights compensate for inherent changes in body form, and 4) relative weight values can be compared between fish of different lengths and from different populations (Blackwell et al. 2000). For these reasons, the relative weight index has become widely used in recent years as a measure of fish condition.

# Methods

## Data Collection

In Fall 2021, length-weight data was collected from juvenile *O. mykiss* during Valley Water’s Juvenile *O. mykiss* Rearing Monitoring on Coyote Creek. For details on data collection methods, including sampling sites and fish processing procedures, please refer to the 2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Coyote Creek report (Valley Water 2022).

## Calculations

The standard weight for each fish was calculated from their measured length using the following standard weight equation developed for juvenile *O. mykiss* ranging from 50 to 200 mm fork-length (Duffy 2006):

$$\log_{10}W_s = -4.790 + 2.928\log_{10}FL$$

Where $W_s$ is the standard weight in grams and FL is the fork-length in mm. This standard weight equation was developed using weight-length data from 121 *O. mykiss*

populations ranging from southern Alaska through central California (Duffy 2006), including populations within the CCC DPS. The equation was formed using the regression-line-percentile technique (Murphy et al. 1990), which is based on 75th-percentile weights and uses $\log_{10}$ transformed data from a series of populations as the statistical population to be modeled (Blackwell et al. 2000).

The slope of the standard weight equation ($b$ = 2.928) developed by Duffy (2006) indicates that juvenile *O. mykiss* ranging from Alaska to central California exhibit slight negative allometric growth (they become more elongated as they grow, $b < 3$), which defies the assumption of Fulton's condition factor of $b = 3$. In contrast, when $b > 3$, a fish experiences positive allometric growth and increases more in weight than predicted by its increase in length (it becomes more rounded as it grows) (Froese et al. 2011).

Standard weight was then used to calculate relative weight of individuals with the equation:

$$W_r = (W / W_s) \times 100$$

Where $W_r$ is the relative weight and W is the weight of the fish being compared in grams. The factor 100 is used to express the equation as a percentage of $W_s$. Note that once $\log_{10}W_s$ was determined for each fish using the standard weight equation, the antilog of these values was used in the above equation to calculate $W_r$.

Lastly, individuals were binned into 25-mm fork-length classes (hereafter referred to as length classes) in order to assess any length-related condition trends in the population sampled (Blackwell et al. 2000). The Kruskal-Wallis test was used to determine if there were statistically significant differences in $W_r$ between length classes ($p < 0.05$). The Kruskal-Wallis test, considered the nonparametric alternative to the one-way ANOVA, was used for this study due to the non-normal data distributions and small sample sizes.

## Relative Weight Target Range

The regression-line-percentile technique used to develop the standard weight equation above uses 75th-percentile weights; therefore, a $W_r$ value of 100 (the actual weight of the fish equals the standard weight) is not an average-sized fish. Rather, it means that

across their range, 25% of the juvenile *O. mykiss* will have a $W_r$ value greater than 100 while 75% will be less than 100. A fish with a $W_r$ of 100 is thus considered to be in better-than-average condition. For the original development of the $W_r$ index (Wege and Anderson 1978), 75th-percentile weights were also used as a standard. Anderson (1980) subsequently recommended that 95−105 be used as a $W_r$ target range in order to aim for fish populations that are in above average condition, and it has since been widely used by fisheries managers.

Nonetheless, Murphy et al. (1991) cautioned against setting a universal target range for optimal condition, believing that “optimal” will vary according to specific management objectives and environmental limitations. Targets for $W_r$ should therefore be established according to the management goals for a given program, but further research is needed to evaluate appropriate $W_r$ target ranges for juvenile *O. mykiss* populations under various management scenarios.

For the purposes of this report, the $W_r$ target range of 95−105 (Anderson 1980) was used to define fish in optimal condition. This $W_r$ target range may be modified in the future as more data is collected and as management objectives for Coyote Creek are refined.

# Results

### Relative Weight Analysis – Coyote Creek

Forty-nine *O. mykiss* were sampled during the 2021 Coyote Creek juvenile rearing monitoring effort. Measured weights ranged from 5.2 to 689 g with a mean weight of 48 g (SD=111). Measured fork-lengths ranged between 80 and 380 mm with a mean fork-length of 133.4 mm (SD=53.1).

The standard weight equation developed by Duffy (2006) applies to juvenile *O. mykiss* between 50 and 200 mm fork-length. Four *O. mykiss* sampled from Coyote Creek had a fork-length greater than 200 mm and were therefore excluded from the relative weight analysis. One additional fish was excluded from the analysis as a weight was not recorded for that individual. Relative weight of the sampled population which could be

analyzed (44 individuals) ranged from 85.9 to 128.7 with a mean $W_r$ of 109.3 (SD=8.7) (Figure 1). Of the 44 *O. mykiss* analyzed, 11 individuals fell within the 95−105 optimal range and 31 were above 105. Two fish were below 95.

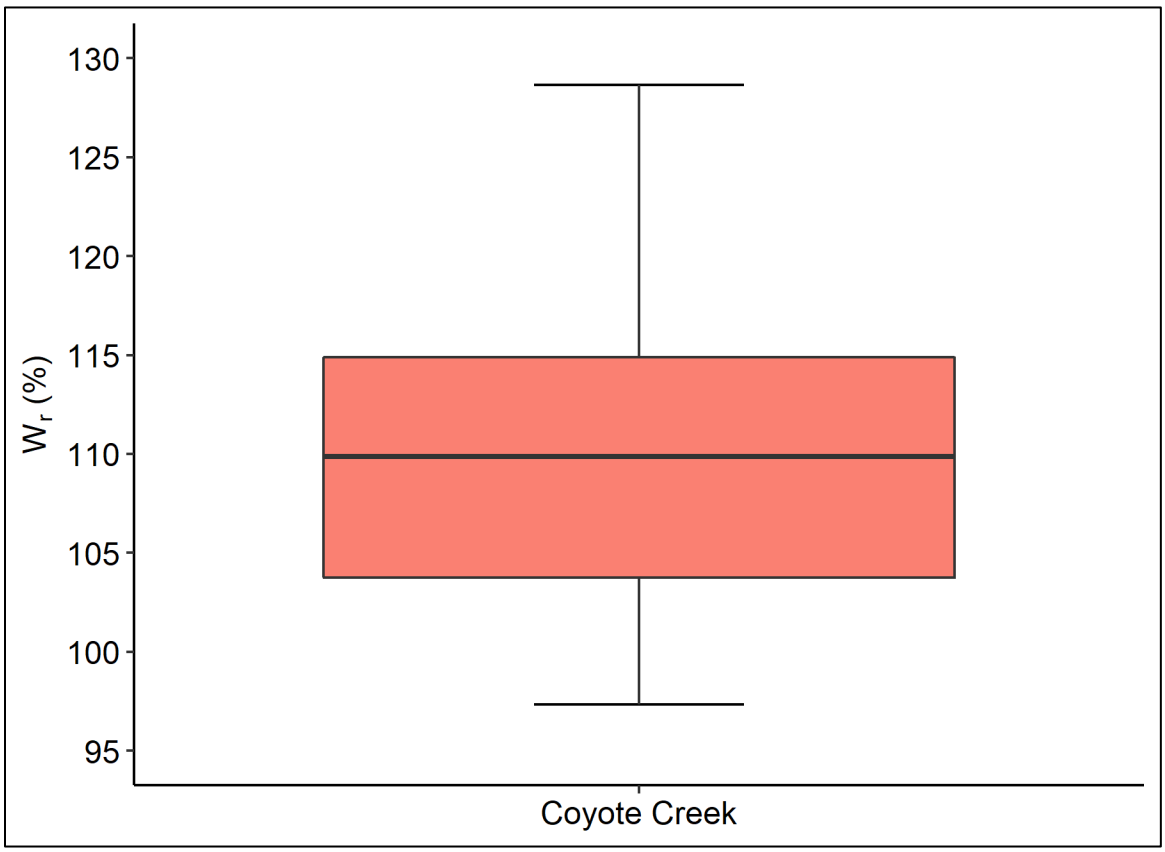


Figure 1. Boxplot (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of juvenile O. mykiss relative weights (Wr) for Coyote Creek (n = 44).

Relative weight plotted as a function of fork-length revealed a slight inverse relationship between the two variables, indicating that relative weight decreased with additional length. However, based on a linear regression analysis (adjusted $R^2$ = -0.0175, 95% CI [-0.192, 0.115], $p$ = 0.6134) the effect of fork-length on $W_r$ was not statistically significant (Figure 2). Summary statistics for $W_r$ per 25-mm length class are provided in Table 1 and distributions are shown in Figure 3. There were no statistically significant differences in mean $W_r$ among length classes as determined by a Kruskal-Wallis test (H = 3.40, df = 3, $p$ = 0.334).

Individual fish measurements from 2021, $W_s$, and $W_r$ are provided in Appendix A.

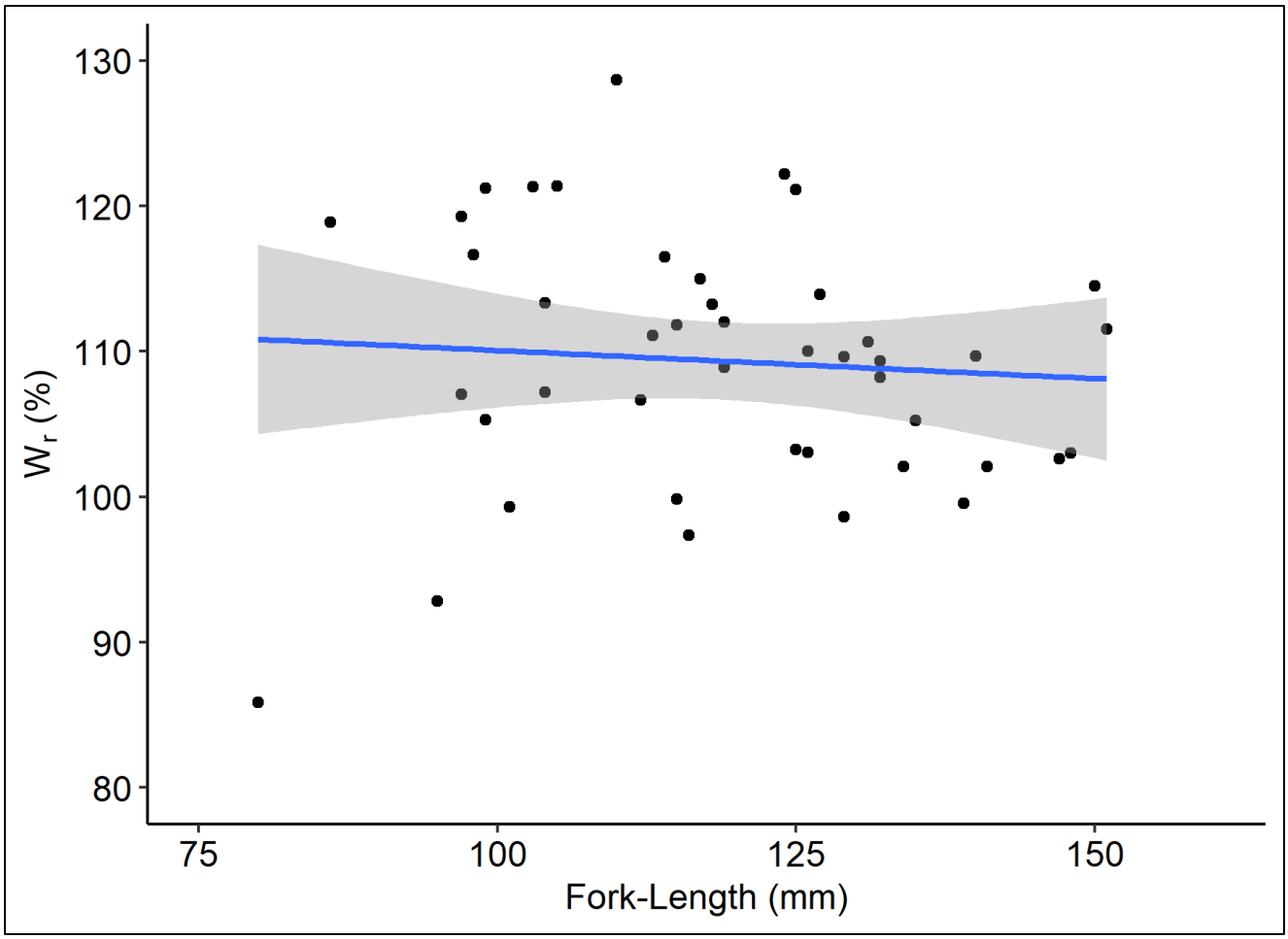


Figure 2. Relative weight (Wr) as a function of fork-length for juvenile O. mykiss sampled in Coyote Creek in 2021. Regression line in blue with confidence bands in gray.

Table 1. Summary statistics of Coyote Creek juvenile O. mykiss relative weights (Wr) per 25-mm length class. Means are presented as the value ± SD. Sample size = n.

| Length Class (mm) | n | Mean $W_r$ (%) | $W_r$ Range (%) |
|---|---|---|---|
| 76-100 | 8 | 109.4 ± 9.61 | 85.9 -121.2 |
| 101-125 | 19 | 109.3±8.8 | 97.3−128.7 |
| 126-150 | 16 | 109.3 ± 8.7 | 98.6−114.5 |
| 151-175 | 1 | 111.5 | 111.5 |

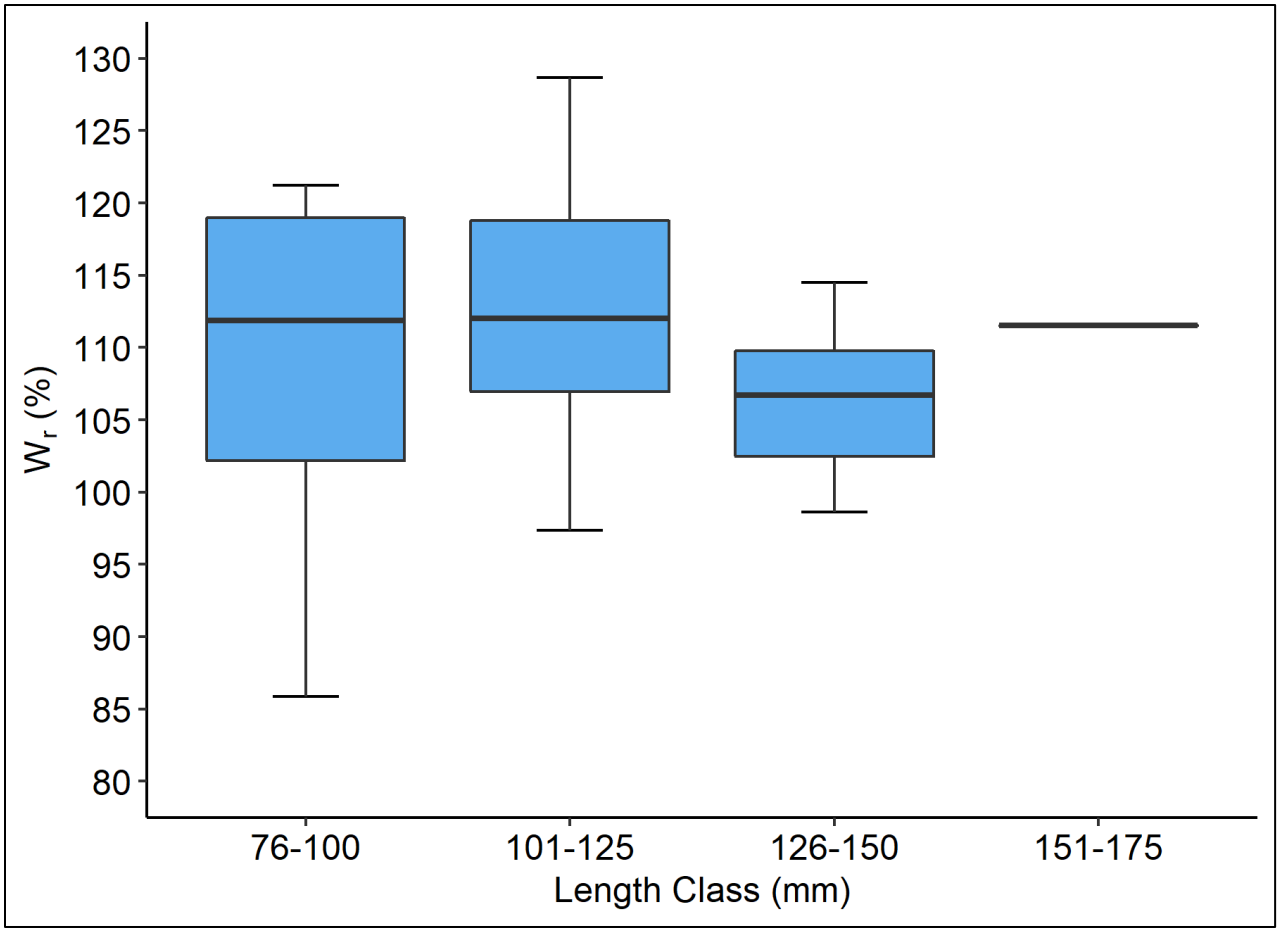

Figure 3. Boxplots (with the median, 25% and 75% quartiles, whiskers extending 1.5 times the interquartile ranges representing Coyote Creek juvenile O. mykiss relative weights (Wr) per 25-mm length class in 2021.

## Discussion

The results indicate that $W_r$ had no correlation with fork-length and there were no significant differences in $W_r$ among length classes for juvenile *O. mykiss* sampled in Coyote Creek in 2021. This suggests that juvenile *O. mykiss* condition did not differ substantially between fish of varying lengths/ages, but the small sample sizes for each length class should be considered when interpreting these results. As more data is collected over the years, any length-related trends in fish condition will become more apparent.

For fish included in the analysis, the lowest relative weight was 85.9 g (80 mm fork-length) and the highest was 111.5 (151 mm fork-length). Relative weight values indicate that juvenile *O. mykiss* in Coyote Creek are in healthy condition overall with 95% of the sampled population (excluding fish >200 mm fork-length and fish that were not weighed)

falling either within or above the optimal $W_r$ target range of 95−105. Fish with an optimal $W_r$ can signify a waterbody with conditions ideal for growth, such as suitable habitat, water quality, and abundant prey (Murphy et al. 1990, Liao et al. 1995). Presence of physical habitat features like large woody debris, boulders, and undercut banks can contribute to improved juvenile *O. mykiss* condition and survival by providing refugia from predators and high flow velocities. Large wood also supports invertebrates, an important food source for salmonids. Riparian vegetation can also provide a source for prey input, as well as provide cover, stream shading, and reduce bank erosion. Coyote Creek has habitat complexity in the form of large woody debris, boulders, rootwads, undercut banks, and emergent vegetation and stream temperatures in this region are within the range defined by NMFS (2016) for most of the year (excluding summer and early fall). Water temperature can likewise influence fish condition and has been documented to impact growth and size of *O. mykiss* and other salmonids through effects on metabolism, behavior, and mortality (Bjornn and Reiser 1991). Young of the year *O. mykiss* fed to satiation exhibited increased growth rates at increased temperatures (up to 19º C) in a laboratory setting (Myrick and Cech 2005), and increased fall-spring temperatures (maximum temperature was approximately 11º C) were also shown to result in increased growth in *O. mykiss* (Railsback and Rose 1999). However, at extreme upper temperatures, growth may be reduced (Bjornn and Reiser 1991). According to NFMS (2016), optimal water temperatures for juvenile *O. mykiss* growth range from 12 to 19°C (~54 to 66°F), though the majority of research done on suitable temperatures for salmonids has been conducted in the Pacific Northwest where environmental conditions are much different than the Central California Coast. Earlier studies have also found relationships between $W_r$ and food supply (Flickinger and Bulow 1993, Liao et al. 1995) and shown that prey biomass is positively correlated with fish condition. Daily average water temperatures in Coyote Creek from December 2020 to November 2021 ranged from 9 to 23°C with a median daily average of 16°C.

The $W_r$ results suggest that environmental conditions in Coyote Creek were suitable for juvenile *O. mykiss* in 2021.

*O. mykiss* feed on drifting and terrestrial insects, as well as bottom dwelling invertebrates, of all life stages (Moyle 2006). Benthic macroinvertebrate (BMI) studies conducted from 2004 to 2019 within the CWMZ indicate that the following prey sources were present: Diptera, Trichopteran, Ephemeroptera, Hypsogastropoda, Megaloptera, Trombidifores, Odonata, Venerida and Hemiptera (CEDEN). This assemblage of BMI are adequate food sources, but Valley Water does not have any data on abundance to further assess if food availability is a driver of fish condition. Previous studies on salmonids have shown that fish weight or growth is inversely related to population density (Close and Anderson 1992, Keeley 2003), and that mean population $W_r$ values are higher in areas where low densities of fish occur (Johnson et al. 1992). This is because individual fish weight and condition are likely to improve when there is reduced competition for food and other resources. During 2021 sampling, the estimated *O. mykiss* population density in Coyote Creek was low at <0.01 *O*. *mykiss*/meter (Valley Water 2022); this may be a contributing factor to high $W_r$ in the system. More reliable conclusions regarding the influence of density on fish condition can be made as sampling continues.

It is worth noting that human error has the potential to skew the results. Accurately measuring the length and weight of fish can be difficult in the field, especially with small fish and under time constraints for handling to reduce mortality. Furthermore, issues taring the scale in the field and excess water on the equipment (scale and measuring board) can affect the weight measurement even when precautions are taken to minimize the amount of water in the measurement.

Our $W_r$ results in Coyote Creek are comparable to other populations of juvenile *O. mykiss* from Alaska through northern California. McLaughlin (2009) calculated the average $W_r$ for over 100 juvenile *O. mykiss* populations of various size throughout northern California, Oregon, Washington, and Alaska. Average $W_r$ for populations in McLaughlin's dataset ranged from 78.2 to 118.1 with an average of 97.7. The 2021 sampled population in Coyote Creek had an average $W_r$ of 109.3, and thus falls within the aforementioned range and above the overall average.

With continued *O. mykiss* juvenile rearing sampling in the system, additional climatic variation (e.g., dry, warm years vs. wet, cold years) and any operational changes (e.g., flow releases or reductions) can be incorporated into the results to determine if there is any correlation between these factors and fish condition. By using $W_r$ as a condition index, we were able to make direct comparisons among fish of different lengths, and thus summarize the overall health of juvenile *O. mykiss* in Coyote Creek. The $W_r$ approach also provides opportunities for comparisons to be made between this system and other *O. mykiss* populations in Santa Clara County in the future.

Juvenile *O. mykiss* sampled in Coyote Creek in 2021 were overall in healthy condition, indicating that environmental conditions within the system are favorable for supporting the growth of juvenile *O. mykiss* and maintaining the  population.

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# Appendix A

**Individual Measurements, Standard Weights ($W_s$), and Relative Weights ($W_r$) of *O. mykiss* Sampled During Fall 2021 Coyote Creek Juvenile Rearing Monitoring**

| FishID | Weight (g) | Fork-Length (mm) | $W_s$(g) | $W_r$(g) | Site | Length Category |
|---|---|---|---|---|---|---|
| F21CY01* | 117.9 | 209 | - | - | Reach 1 | 201-225 |
| F21CY02 | 43.4 | 151 | 38.91 | 111.54 | Reach 1 | 151-175 |
| F21CY03 | 25.2 | 126 | 22.90 | 110.03 | Reach 2 | 126-150 |
| F21CY04 | 11.9 | 101 | 11.99 | 99.29 | Reach 2 | 101-125 |
| F21CY05 | 13.7 | 99 | 11.30 | 121.20 | Reach 2 | 76-100 |
| F21CY06 | 11.4 | 97 | 10.65 | 107.06 | Reach 2 | 76-100 |
| F21CY07 | 8.9 | 86 | 7.49 | 118.90 | Reach 3 | 76-100 |
| F21CY08 | 30.4 | 139 | 30.53 | 99.57 | Reach 4 | 126-150 |
| F21CY09 | 24.2 | 129 | 24.54 | 98.63 | Reach 4 | 126-150 |
| F21CY10 | 28.7 | 132 | 26.24 | 109.36 | Reach 4 | 126-150 |
| F21CY11 | 17.5 | 115 | 17.53 | 99.84 | Reach 4 | 101-125 |
| F21CY12 | 26.9 | 129 | 24.54 | 109.63 | Reach 4 | 126-150 |
| F21CY13 | 26.7 | 124 | 21.85 | 122.17 | Reach 4 | 101-125 |
| F21CY14 | 9.3 | 95 | 10.02 | 92.83 | Reach 4 | 76-100 |
| F21CY15 | 5.2 | 80 | 6.06 | 85.85 | Reach 4 | 76-100 |
| F21CY17 | 21.7 | 119 | 19.37 | 112.01 | Reach 5 | 101-125 |
| F21CY16 | 21.1 | 119 | 19.37 | 108.91 | Reach 4 | 101-125 |
| F21CY18 | 12.8 | 98 | 10.97 | 116.65 | Reach 4 | 76-100 |
| F21CY19 | 16.3 | 105 | 13.43 | 121.38 | Reach 4 | 101-125 |
| F21CY20 | 21.4 | 118 | 18.90 | 113.23 | Reach 4 | 101-125 |
| F21CY21 | 19.8 | 110 | 15.39 | 128.67 | Reach 4 | 101-125 |
| F21CY22 | 27.1 | 125 | 22.37 | 121.12 | Reach 4 | 101-125 |
| F21CY23 | 12.7 | 97 | 10.65 | 119.27 | Reach 5 | 76-100 |
| F21CY24 | 18.5 | 113 | 16.65 | 111.11 | Reach 5 | 101-125 |
| F21CY25 | 23.1 | 125 | 22.37 | 103.24 | Reach 5 | 101-125 |
| F21CY26 | 14.8 | 104 | 13.06 | 113.34 | Reach 5 | 101-125 |
| F21CY27 | 28.4 | 131 | 25.67 | 110.65 | Reach 6 | 126-150 |
| F21CY28 | 34.2 | 140 | 31.18 | 109.69 | Reach 6 | 126-150 |
| F21CY29 | 19.6 | 115 | 17.53 | 111.82 | Reach 5 | 101-125 |
| F21CY30 | 36.9 | 147 | 35.97 | 102.59 | Reach 5 | 126-150 |
| F21CY31 | 32.5 | 141 | 31.84 | 102.09 | Reach 5 | 126-150 |
| F21CY32 | 17.5 | 116 | 17.98 | 97.34 | Reach 5 | 101-125 |
| F21CY33 | 11.9 | 99 | 11.30 | 105.28 | Reach 6 | 76-100 |
| F21CY34 | 37.8 | 148 | 36.69 | 103.03 | Reach 6 | 126-150 |
| F21CY35 | 28 | 134 | 27.43 | 102.09 | Reach 6 | 126-150 |

| | | | | | | |
|---|---|---|---|---|---|---|
| F21CY36 | 15.4 | 103 | 12.69 | 121.32 | Reach 6 | 101-125 |
| F21CY37 | 17.3 | 112 | 16.22 | 106.64 | Reach 6 | 101-125 |
| F21CY38 | 28.4 | 132 | 26.24 | 108.21 | Reach 6 | 126-150 |
| F21CY39 | 29.5 | 135 | 28.03 | 105.25 | Reach 6 | 126-150 |
| F21CY40 | 43.7 | 150 | 38.16 | 114.52 | Reach 6 | 126-150 |
| F21CY41 | 23.6 | 126 | 22.90 | 103.05 | Reach 6 | 126-150 |
| F21CY42 | 21.2 | 117 | 18.44 | 115.00 | Reach 7 | 101-125 |
| F21CY43* | 689 | 380 | - | - | Reach 7 | 375-400 |
| F21CY44 | 19.9 | 114 | 17.09 | 116.48 | Reach 7 | 101-125 |
| F21CY45** | - | 151 | - | - | Reach 7 | 151-175 |
| F21CY46* | 418 | 320 | - | - | Reach 7 | 301-325 |
| F21CY47 | 26.7 | 127 | 23.44 | 113.91 | Reach 7 | 126-150 |
| F21CY48* | 132.3 | 252 | - | - | Reach 7 | 251-275 |
| F21CY49 | 14 | 104 | 13.06 | 107.21 | Reach 7 | 101-125 |

*The standard weight equation used in the analysis applies to juvenile *O. mykiss* between 50-200 mm fork-length; therefore, individuals with fork-lengths >200 mm were excluded.

** A standard weight could not be calculated for fish without a recorded weight. These individuals were excluded from the analysis.

# 2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Upper Penitencia Creek

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January 2022

# Executive Summary

To better understand juvenile steelhead (*Oncorhynchus mykiss, O. mykiss*) abundance and distribution, Valley Water performed index reach monitoring for juvenile *O. mykiss* on Upper Penitencia Creek. The goal of the monitoring was to document the abundance, distribution, and densities of all fish in Upper Penitencia Creek, as well as to collect *O. mykiss* genetic information and continue tagging fish for a tracking study implemented in 2019 using Passive Integrated Transponder (PIT) tags. Monitoring was conducted under the National Marine Fisheries Service Section 10(a)1(A) Recovery Permit # 16417-3M and California Department of Fish and Wildlife Scientific Collecting Permit, Specific Use Permit number S-191480002-21124-001.

On November 15, 2021, monitoring was conducted at 4 monitoring stations on Upper Penitencia Creek. Multi-pass depletion backpack electrofishing was conducted at each station. This juvenile rearing monitoring is part of a continuing effort to better understand *O. mykiss* distribution and abundance in the Coyote Creek Watershed. This is the third year of surveys on Upper Penitencia Creek. Similar to 2020, only four of the five stations were sampled this year due to drought-induced dry backs at the most downstream station. However, no *O. mykiss* were detected in Upper Penitencia Creek in 2021. Other native fish species were present, and no non-native fish were observed or collected. A better understanding of *O. mykiss* populations in Upper Penitencia Creek will develop as more data becomes available.

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# 1. Introduction

The Coyote Creek Watershed is the largest watershed in Santa Clara County, encompassing over 829 square kilometers. The eastern and southern portions of the watershed drain most of the western face of the Diablo Mountain Range where the creek originates at elevations up to 1,110 meters. These upper watershed areas remain undeveloped with little anthropogenic disturbance. The northern and western portions of the watershed are comprised of the Santa Clara County valley floor. Portions of the valley floor are extensively urbanized with patches of undeveloped parks and open agricultural lands. Coyote Creek has 29 tributaries and flows northwest through the valley, approximately 68 kilometers from the headwaters, where it enters the southern extent of the San Francisco Bay.

The Coyote Creek Watershed supports the federally threatened Central California Coast steelhead (*Oncorhynchus mykiss; O. mykiss* for the remainder of this document) distinct population segment. Two systems in the Coyote Creek Watershed are defined as critical habitat for *O. mykiss*: Coyote Creek and Upper Penitencia Creek. Coyote Creek critical habitat extends from the creek's confluence with the San Francisco Bay to the base of the Leroy Anderson Dam. Upper Penitencia Creek critical habitat extends from the creek's confluence with Coyote Creek to the base of the dam at Cherry Flat Reservoir. To better understand *O. mykiss* abundance and distribution within Upper Penitencia Creek, Valley Water performed index reach monitoring for juvenile *O. mykiss*. The goal of the monitoring was to document the abundance, distribution, and densities of all fish in Upper Penitencia Creek, as well as to collect *O. mykiss* genetic information and implement a tracking study using Passive Integrated Transponder (PIT) tags.

# 2. Methods

## 2.1 Station Selection

The area of study for Upper Penitencia Creek was defined as the section of the creek between the Piedmont Road overcrossing to the upper extent of the City of San Jose's property upstream of Alum Rock Park. This area was selected as it had the highest

likelihood of being wetted throughout the sampling period. Five sampling stations were randomly selected in 2019, however drought induced dry backs prevented sampling in some areas in both 2020 and 2021

A total of four stations were sampled on Upper Penitencia Creek in 2021 (Figure 1). Stations were resampled if feasible based on the 2020 sampling stations. Site selection was limited to locations of Valley Water ownership or easement, or to locations owned by other government agencies.

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Figure 1. 2021 Upper Penitencia Creek juvenile rearing monitoring stations.

## 2.2 Sampling Methods

Each monitoring station was between 35.0 and 40.0 m in length. The target length was 40.0 m, but deviations in length occurred based on the ability to isolate each reach. Multi-pass depletion backpack electrofishing was deployed at every station (Johnson et al. 2007). This method allowed for consistency with previous juvenile rearing monitoring methods, the extrapolation of population estimates, and the sampling of a variety of habitat types.

### *Habitat Typing*

Each monitoring station was habitat typed using the classifications following Ode (2007) (Table 1). Average wetted width and depth were estimated and the presence of any anthropogenic influences (bridge, dam, etc.) was noted. Prior to the start of sampling, ambient weather conditions were noted, and water quality data (dissolved oxygen, conductivity, turbidity, and temperature) was collected at the downstream end of each monitoring station. Ocular estimates of percent cover of macrophytes/emergent vegetation, boulders, woody debris, undercut banks, overhanging vegetation, submerged roots (live and dead), and artificial structures were recorded for each monitoring station. Each habitat feature was ranked on a 0–4-point scale described in Table 2, with 0 being absent and 4 being a very heavy presence. Primary and secondary substrate types were determined based upon ocular estimates (Table 3; Ode 2007).

Table 1. Habitat type classifications (Ode 2007).

| Habitat Type | Description |
|---|---|
| **Cascades** | Short, high gradient drop in streambed elevation often accompanied by boulders and considerable turbulence. |
| **Falls** | High gradient drop in elevation of the streambed associated with an abrupt change in the bedrock. |
| **Rapids** | Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles. |
| **Riffles** | Shallow sections where the water flows over coarse streambed particles that create mild to moderate surface turbulence. |
| **Step-Run** | A series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope. |
| **Runs** | Sections without flow obstructions. The stream bed is typically even, and the water flows faster than it does in a pool. |
| **Glides** | A section of stream with little or no turbulence, but faster velocity than pools. |
| **Pool** | A reach of stream that is characterized by deep, low-velocity water and a smooth surface. |

Table 2. Percent cover of physical habitat features ocular estimate scale (Ode 2007).

| Scale | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| **Percent Coverage** | 0% | <10% | 10-40% | 40-75% | >75% |
| **Descriptor** | Absent | Sparse | Moderate | Heavy | Very Heavy |

Table 3. Substrate classes (Ode 2007).

| Particle Size | Size Category |
|---|---|
| **Boulder** | > 250 mm |
| **Cobble** | 65-250 mm |
| **Gravel** | 2.0-65 mm |
| **Sand** | <2.0 mm (gritty texture) |
| **Silt/Clay** | Not gritty |
| **Bedrock** | No individual particles |

### *Electrofishing*

Block nets were installed at both the upstream and downstream ends of each sampling station to keep fish from immigrating into or emigrating out of the reaches. Block nets were secured with rebar and spreaders to hold the nets in place and keep the top of the nets above water. Large rocks were used to add extra security to the lead line and keep the bottom of the net flush with the channel bottom. Electrofishing then commenced from down- to upstream and laterally across the channel to ensure all wetted portions of the reach were sampled. Smith-Root® LR24 Backpack Electrofishing Units were used at all monitoring stations. The LR24 quick setup option was used to establish the initial power and waveform settings, and the output was verified with conductivity readings and manually adjusted as appropriate. Electrofishers were run using direct current at a frequency of 30 Hz, duty cycle of 12%, and voltage that ranged between 120 and 160 volts (depending on field site conductivity). Each electrofisher operator was flanked by two netters. Verbal communication and spatial awareness were used to ensure the entire width of the stream was covered. Triple-pass depletion electrofishing methods were deployed at all stations.

### *Fish Processing*

Fish were held in aerated dark-colored containers during processing. Length measurements were recorded to the nearest millimeter at the fork of the tail (fork-

length). For each pass, up to 30 individuals of each species were measured, and all other individuals of that species were tallied for a total number.

Once processing was completed, all fish were transferred to an in-channel live car for recovery. The live car was placed outside of the sampling reach and outside of the field of current from the electrofisher in an area with flow, shade, and low relative turbidity from the time processing ended, until the sampling event was complete, to allow fish time to recover and to prevent processed fish from re-entering the sampling reach. All fish were released after the final pass.

## 2.3 Data Analysis

MicroFish 3.0 was used to calculate population estimates for each station using a maximum-likelihood iterative process (MLIP); the associated standard errors and 95% confidence intervals (CI) are reported herein. This method uses the number of fish captured (n) and the difference in capture between electrofishing passes (i.e., depletion rate) to calculate an estimate of individuals likely to have been present but not captured, thus generating a population estimate (N) for each species for each station. Population estimates are restricted to the sampled areas and are only an index of the overall population. If the number of a particular species was too low (i.e., only one fish was captured) or all individuals of a particular species were captured on the first pass (with no individuals of that species captured on subsequent passes), then a MLIP population estimate could not be produced. If the lower confidence interval was less than the total catch it was set equal to total catch, as it is certain at least that many fish were present in the sampling reach. These calculations assume: 1) fish emigration and immigration were prevented by the installation of upstream and downstream block nets, 2) shocking efficiency did not change between passes, 3) staff did not become more efficient at using the equipment, and 4) fish did not learn to avoid the electrical field between passes.

# 3. Results

Sampling occurred at four stations on Upper Penitencia Creek on November 15, 2021, and weather conditions were overcast with no precipitation. Flows during the sampling event were low, and in some instances, flow limited up- and downstream movement of fish. Based on ALERT Gage 5001 - Upper Penitencia Creek at Piedmont Ave, flows at the time of the sampling were 1.1cfs. This is the nearest gage for accurately describing flow conditions and is located outside of Alum Rock Park and downstream of the four sampling stations.

*UP002*

This station is located at the downstream extent of the City of San Jose's Alum Rock Park and has been sampled every year since 2019. The surrounding land use is rural park lands with a two-lane road parallel to the creek channel. The monitoring station was 40.0 m in length with an average wetted width of 1.5 m and an average depth of 0.6 m. Three habitat types were present within the station: riffle, glide, and step-pool (Figure 2). The step-pool habitat made up 20% of the sampled reach, the riffle 23%, and the glide the remaining 57%. The primary substrate was cobble with a secondary substrate of boulders. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 4.

Figure 2. Photos of station UP002 looking upstream (left) and looking downstream (right).

Table 4. UP002 water quality data and ocular estimates of habitat complexity.

| Water Quality | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/L)** | **Turbidity (NTU)** |
| 2170 | 13.55 | 8.38 | 12.30 |

| Habitat Complexity Scoring | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 1 | 2 | 1 | 0 | 2 | 1 | 0 |

Three fish species were captured during the survey and all were native: Southern coastal California roach (SCC; *Hesperoleucus venustus subditus*), riffle sculpin (*Cottus gulosus*), and Sacramento sucker (*Catostomus occidentalis*). Fish captured and associated population estimates are summarized in Table 5. The most abundant species encountered was SCC roach (n=70). The MLIP indicated that the number of SCC roach and riffle sculpin were likely higher than what was captured, and a population estimate could not be calculated for Sacramento sucker as only one individual was captured. No *O. mykiss* were detected.

Table 5. Number of fish captured and population estimates at station UP002.

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| SCC roach | Yes | 70 | 91 | 14.095 | 70-119 |
| Riffle sculpin | Yes | 15 | 41 | 70.028 | 15-183 |
| Sacramento sucker | Yes | 1 | 1 | 0 | 1-1 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

*UP003*

This station is located within Alum Rock Park and has been sampled every year since 2019. The surrounding land use consists of a manicured park setting with parking lots, picnic areas, and lawns. The monitoring station was 40.0 m in length with an average wetted width of 5.0 m and an average depth of 0.1 m. Three habitat types were present within the station: run, riffle, and glide (Figure 3). Habitat at the station was 50% run,

13% riffle, and 37% glide. The primary substrate was boulders with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 6.

Figure 3. Photos of station UP003 looking upstream (left) and looking downstream (right).

Table 6. UP003 water quality data and ocular estimates of habitat complexity.

| Water Quality | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/L)** | **Turbidity (NTU)** |
| 1940 | 13.91 | 9.3 | 9.8 |

| Habitat Complexity Scoring | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 1 | 3 | 1 | 1 | 3 | 1 | 0 |

Three fish species were captured during the survey and all were native: SCC roach, riffle sculpin, and Sacramento sucker. Fish captured and associated population estimates are summarized in Table 7. The most abundant species encountered was SCC roach (n=43), followed by riffle sculpin (n=11). No *O. mykiss* were detected. The MLIP indicated that the number of SCC roach was likely higher than what was captured. The MLIP did not show that the riffle sculpin population was higher than observed, and

a population estimate could not be calculated for Sacramento sucker as only one individual was captured.

Table 7. Number of fish captured and population estimates at station UP003.

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| SCC roach | Yes | 43 | 51 | 6.91 | 43-65 |
| Riffle sculpin | Yes | 11 | 11 | 1.27 | 11-14 |
| Sacramento sucker | Yes | 1 | 1 | 0 | 1-1 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

*UP004*

This station is located within Alum Rock Park and has been sampled every year since 2019. The station is situated amongst rural park lands, and hiking and walking trails border the creek in this area. The monitoring station was 38.0 m in length with an average wetted width of 2.0 m and an average depth of 0.15 m. Four habitat types were present within the station: pool, glide, run, and riffle (Figure 4). Habitat at the station was 26% pool, 26% glide, 10% run, and 38% riffle. The primary substrate was boulders with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 8.

Figure 4. Photos of station UP004 looking upstream (left) and looking downstream (right).

Table 8. UP004 water quality data and ocular estimates of habitat complexity.

| Water Quality | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/L)** | **Turbidity (NTU)** |
| 858 | 12.4 | 9.32 | 12.7 |

| Habitat Complexity Scoring | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 2 | 3 | 1 | 0 | 3 | 1 | 0 |

Two fish species were captured during the survey and both were native: SCC roach and riffle sculpin. The more abundant species encountered was riffle sculpin (n=75). No *O. mykiss* were detected. Fish captured and associated population estimates are summarized in Table 9. According to the MLIP, the number of individuals within the reach for both species was likely higher than what was captured.

Table 9. Number of fish captured and population estimates at station UP004.

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| SCC roach | Yes | 48 | 59 | 8.967 | 48-77 |
| Riffle sculpin | Yes | 75 | 97 | 14.188 | 75-125 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

*UP005*

This station is located between station UP003 and UP004 in Alum Rock Park and was sampled in 2020. The station is situated amongst rural park lands, and hiking and walking trails border the creek in this area. The monitoring station was 40.0 m in length with an average wetted width of 2.5 m and an average depth of 0.6 m. Three habitat types were present within the station: glide, step-run, and pool (Figure 5). Glide habitat made up 50% of the sampled area, followed by step-run habitat at 25%, with pool habitat making up the remaining 25%. The primary substrate was boulders with a secondary substrate of cobble. Results of the water quality monitoring and the ocular assessment of habitat complexity can be seen in Table 10.

Figure 5. Photos of station UP005 looking upstream (left) and looking downstream (right).

Table 10. UP005 water quality data and ocular estimates of habitat complexity.

| Water Quality | | | |
|---|---|---|---|
| **Conductivity (µS/cm)** | **Temperature (°C)** | **Dissolved Oxygen (mg/L)** | **Turbidity (NTU)** |
| 2030 | 13.83 | 8.31 | 17.7 |

| Habitat Complexity Scoring | | | | | | |
|---|---|---|---|---|---|---|
| **Macrophytes/Emergent Vegetation** | **Boulders** | **Woody Debris** | **Undercut Banks** | **Overhanging Vegetation** | **Roots** | **Artificial Structures** |
| 1 | 3 | 1 | 1 | 2 | 0 | 2 |

Three fish species were captured during the survey and all were native: SCC roach, riffle sculpin, and Sacramento sucker. The most abundant species encountered was riffle sculpin (n=70). No *O. mykiss* were detected. Fish captured and associated population estimates are summarized in Table 11. The MLIP indicated that the number of SCC roach and riffle sculpin was likely higher than what was captured, whereas a population estimate for Sacramento sucker could not be calculated as only one individual was observed.

Table 11. Number of fish captured and population estimates at station UP005.

| Species | Native | n | N | SE | 95% CI |
|---|---|---|---|---|---|
| SCC roach | Yes | 45 | 93 | 56.605 | 45-205 |
| Riffle sculpin | Yes | 70 | 204 | 174.314 | 70-548 |
| Sacramento Sucker | Yes | 1 | 1 | 2.027 | 1-1 |

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

# 4. Conclusion

No *O. mykiss* were collected during the 2021 sampling event in comparison to the fifteen that were captured in 2020, though it is of note that no *O. mykiss* have ever been captured at UP002 in any of the years in which sampling has been conducted (Valley Water 2020). A number of factors have been identified as likely contributors to their decline, one being the current prolonged drought. Flows in Upper Penitencia Creek have been low during the 2020-2021 drought, and O. *mykiss* densities may have suffered as a result. The physical habitat conditions at all sites were suitable to support *O. mykiss*; however, the creek within Alum Rock Park contains unique geological formations, and mineral spring seeps release minerals such as sulfur, sodium chloride, magnesium, iron, and calcium carbonate into the waters of Upper Penitencia Creek. It is possible that the change in water chemistry is altering the distribution of *O. mykiss*. This could be especially true during the low flow conditions that were present during the sampling period.

O. *mykiss* are likely still present in the system as the sampling only occurs in a subset of available habitat. Furthermore, O. *mykiss* have been captured at these locations in past year's efforts, and evidence of *O. mykiss* environmental DNA suggests that they are in fact still present somewhere in the system (Valley Water 2021). Environmental DNA, or eDNA, is genetic material shed by organisms into the surrounding aquatic or terrestrial environment via skin, hair, excrement, etc. and can be detected by collecting an environmental sample (e.g., water, soil) for analysis in a lab. Most often, eDNA is used to detect the presence of individual species of interest. As part of the FERC Order Compliance Project for Anderson Reservoir and Dam, Valley Water conducts eDNA monitoring to evaluate the presence of *O. mykiss* within the functional Cold Water

Management Zone of Coyote Creek. This monitoring also includes collecting water samples from a location on Upper Penitencia Creek (near station UP004), where *O. mykiss* DNA has consistently been present (Valley Water 2021).

The average *O. mykiss* density (fish per meter) for all 2021 monitoring stations in Upper Penitencia Creek was 0.0 *O. mykiss*/m (based on the number of fish caught [n]). The *O. mykiss* density at each station for 2019 through 2021 can be seen in Figure 7 below. Densities at each station with *O. mykiss* observed are low and relatively similar, with the exception of UP004 in 2019 which had a substantially higher density than any other station in any year at over 1.4 *O. mykiss*/m. In part, this is likely due to the better flow conditions experienced in 2019. Station UP004 is also located upstream of the mineral spring seeps, which may also explain why a higher density of *O. mykiss* was observed.

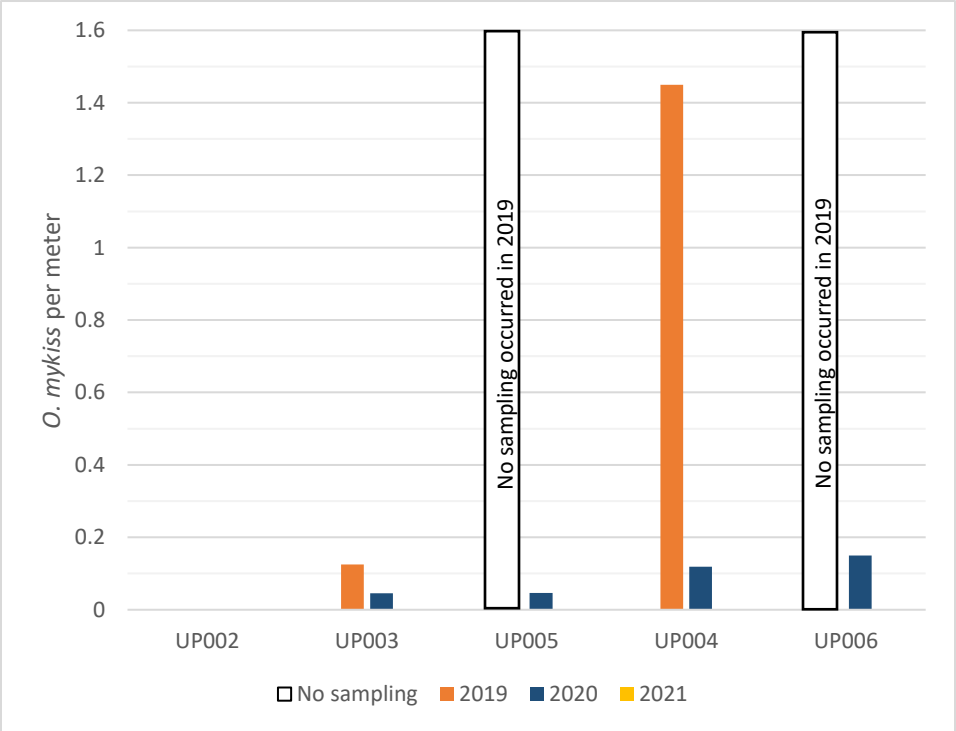


Figure 6. Observed *O. mykiss* densities at the five monitoring stations on Upper Penitencia Creek in 2019, 2020, and 2021. No sampling occurred at UP005 and UP006 in 2019. No *O. mykiss* have been captured at UP002 in any year, and no *O. mykiss* were captured at any site in 2021.

The average densities (*O. mykiss*/m) and median fork-length of *O. mykiss* detected in Upper Penitiencia Creek from 2019 to 2021 are provided in Table 14. Sampling in 2019 yielded the highest density, which has continued to decline over time, while 2020 had *O. mykiss* with the highest fork-lengths.

Table 12. 2019 – 2021 average density and median fork-length of *O. mykiss* captured within Upper Penitencia Creek.

| Year | *O. mykiss*/meter | Median Fork-length (mm) |
|---|---|---|
| 2019 | 0.39 | 92 |
| 2020 | 0.05 | 147 |
| 2021 | 0.00 | – |

In 2021, three species of native fish were observed on Upper Penitencia Creek while no non-native species were observed. Although O. *mykiss* were not detected at any of the stations, species commonly associated with *O. mykiss* and that share similar habitat requirements were encountered, indicating that the habitat is likely suitable. It is difficult to assess any trends at this time, but a better understanding of *O. mykiss* abundance and distribution will develop as more data becomes available through continued sampling.

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# Coyote Creek Watershed *Oncorhynchus mykiss* 2020 – 2021 Migration Monitoring Using Passive Integrated Transponder Tags

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August 2021

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# Appendix

Appendix A: PIT Tag Master List

# 1. Introduction

The Coyote Creek Watershed is the largest watershed in Santa Clara County, encompassing over 829 square kilometers (km). The eastern and southern portions of the watershed drain most of the western face of the Diablo Mountain Range where the headwaters originate at elevations up to 1,110 meters. These upper watershed areas remain undeveloped with little anthropogenic disturbance. The northern and western portions of the watershed are comprised of the Santa Clara County valley floor. Portions of the valley floor are extensively urbanized with patches of undeveloped parks and open agricultural lands. Coyote Creek has 29 tributaries and flows northwest through the valley, approximately 68 km from the headwaters, where it enters the southern extent of the San Francisco Bay. Downstream of Anderson Dam, Coyote Creek Watershed supports the Central California Coast steelhead (*Oncorhynchus mykiss*) distinct population segment, which is a federally threatened species. Two systems in the Coyote Creek Watershed support and are defined as critical habitat for *O. mykiss*: Coyote Creek mainstem (below Leroy Anderson Dam to San Francisco Bay) and Upper Penitencia Creek (below Cherry Flat Reservoir to the Coyote Creek confluence). Though critical habitat on Upper Penitencia Creek extends to the base of the Cherry Flat Dam, natural barriers (e.g., Alum Rock Falls) preclude steelhead from reaching the most upstream designated critical habitat.

In fall 2019, Valley Water designed and implemented the first year of the Coyote Creek Watershed Juvenile *O. mykiss* Rearing Sampling to determine the presence of *O. mykiss* as well as the composition of other fish species in the Coyote Creek Watershed. Per the February 20, 2020 order from the Federal Energy Regulatory Commission (FERC) regarding Leroy Anderson Dam, the Santa Clara Valley Water District (Valley Water) was to “begin draining the reservoir to deadpool, 488 ft. elevation, as quickly and safely as possible starting no later than October 1, 2020.” Based on information regarding the cold-water supply stored in Anderson Reservoir, it was predicted that habitat conditions in Coyote Creek would be unsuitable for *O. mykiss* by September 2020. As directed by the FERC Compliance Project Technical Working Group, a fish rescue and relocation was conducted in Coyote Creek from the base of Leroy Anderson

Dam to the upstream end of Ogier Ponds in late August 2020 to relocate fish before conditions became unsuitable (Valley Water and Stillwater Sciences 2020). Due to the fish rescue activities, no fall juvenile rearing sampling was conducted in Coyote Creek. Sampling in Upper Penitencia Creek occurred in August of 2020. For more details see the 2020 Juvenile Oncorhynchus mykiss Rearing Monitoring in Upper Penitencia Creek (Valley Water 2020)

In Upper Penitencia Creek, Valley Water staff injected passive integrated transponder (PIT) tags into captured *O. mykiss* of suitable size to passively track individuals movement in the system via antenna arrays. A PIT tag is a small passive transponder that contains a unique 15-digit number, which allows researchers to mark fish with distinct codes. No tagging occurred in Coyote Creek.

When a PIT tagged fish swims through a pre-installed antenna array, the unique identifying number is recorded at that location via a half- and/or full-duplex (HDX and/or FDX, respectively) radio-frequency identification (RFID) reader. A FDX reader generates a continuous magnetic field to detect PIT tags and receive information from nearby PIT tags simultaneously. HDX readers generate short magnetic pulses that wirelessly charge a capacitor inside a PIT tag. When the charge field turns off, the tag uses the stored power to send the tag number back to the reader without interference from the reader. While FDX systems have faster detection rates, HDX emit a stronger signal which can be detected from a greater distance (Oregon RFID 2019, Biomark 2020). In addition to relaying the tag number, information on date and time is recorded when a tag is detected in the proximity of the system. The distance to which a tag can be detected from the antenna is variable based on the antenna read range. Many factors contribute to the read range of passive tags including operation frequency, antenna power, tag orientation, and interference from other devices (Biomark 2020). In the Coyote Creek Watershed, two stationary tag reading systems have been deployed: one on the Coyote Creek mainstem and one on Upper Penitencia Creek (Figure 1). These are HDX systems. A submersible antenna was also deployed in Alum Rock Park on Upper Penitencia Creek to increase detection probability upstream of the stationary antenna (Figure 1). The submersible antenna reads both FDX and HDX tags.

Figure 1. PIT tag antennas on Coyote and Upper Penitencia Creek.

The goal of the PIT study is to gain a better understanding of juvenile *O. mykiss* migratory timing and behavior in the Coyote Creek Watershed and glean information on the proportion of the population show migratory tendencies and from which sub-watershed.

# 2. Methods

### 2.1 *O. mykiss* PIT Tagging

*O. mykiss* with a fork-length between 65 mm and 150 mm received a 12 mm HDX PIT tag. *O. mykiss* with a fork-length of 150 mm or greater received a 23 mm HDX PIT tag (Figure 2). Sampling to capture fish for tagging, occurred at four juvenile rearing stations on Upper Penitencia Creek: UP006, UP005, UP004, UP003. All fish were tagged and released in the reach in which they were captured (Figure 3). For more information on the sampling effort see the 2020 Juvenile Oncorhynchus mykiss Rearing Monitoring in Upper Penitencia Creek (Valley Water, 2020). Eight of the thirteen fish captured and tagged in the Coyote Creek Watershed received a 23 mm tag. The remaining five fish received a 12 mm tag (Table 1).  PIT tag numbers and associated biological data for all fish tagged by Valley Water in Santa Clara County are included in Appendix A. All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 1999) by staff trained in the procedure. The 13 fish tagged in 2020, plus any remaining fish from the tagging effort in 2019 were available for detection.

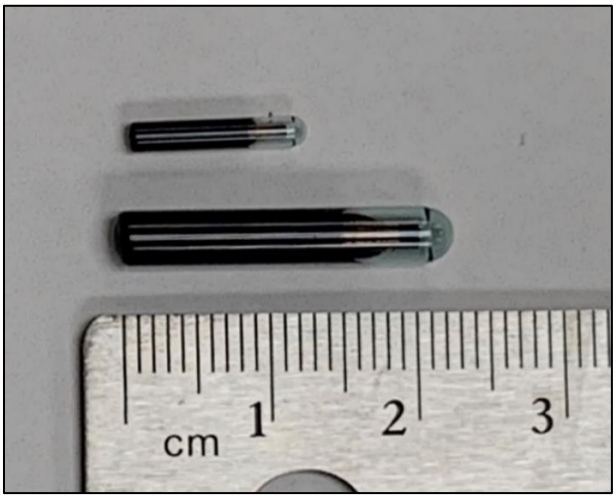

Figure 2. 12 mm (top) and 23 mm (bottom) HDX PIT tags.

Figure 3. Tagging stations on Upper Penitencia Creek.

Table 1. Data for *O. mykiss* tagged on Upper Penitencia Creek in August 2020.

| Date | Station | Weight | Length | Tag Number |
|---|---|---|---|---|
| 08/04/2020 | UP003 | n/a | 144 | 982.126058146121 |
| 08/04/2020 | UP005 | n/a | 104 | 982.126058146086 |
| 08/04/2020 | UP005 | n/a | 123 | 982.126058146066 |
| 08/04/2020 | UP004 | 26.4 | 130 | 982.126058146954 |
| 08/04/2020 | UP004 | 38.2 | 147 | 982.126058146943 |
| 08/04/2020 | UP004 | 25.4 | 129 | 982.126058146947 |
| 08/04/2020 | UP004 | 22.2 | 121 | 982.126058146948 |
| 08/04/2020 | UP006 | 36.1 | 151 | 900.228000613801 |
| 08/04/2020 | UP006 | 79.4 | 196 | 900.228000613806 |
| 08/04/2020 | UP006 | 39.3 | 152 | 900.228000613803 |
| 08/04/2020 | UP006 | 59.1 | 178 | 900.228000613802 |
| 08/04/2020 | UP006 | 124 | 237 | 900.228000613804 |
| 08/04/2020 | UP006 | 31.5 | 142 | 982.126058146963 |

## 2.2 Antenna Construction and Operation

The two stationary antennas installed in the Coyote Creek Watershed used HDX RFID technology. The basic components of the HDX arrays consisted of an RFID reader, a power source, a tuning capacitor, and an antenna. When readers detect a PIT tag, they store the following detection data: PIT tag number, date and time stamp, and number of empty scans since last detection. The antenna was programmed to scan for tags 10 times per second.

The Biomark submersible antenna installed in Upper Penitencia Creek used RFID technology and was capable of detecting ISO11784/11785, FDX and HDX tags. It is designed for low power consumption and high adaptability to environmental changes. The unit consists of an RFID reader (IS1001, Biomark), a battery pack, and an antenna. Data is downloaded monthly via Bluetooth connection.

PIT tag detections recorded by the antennas installed in the Coyote Watershed indicate proximity to the antenna at a given time but do not indicate direction of movement. Assumptions must be made about direction based on the fish release point after tagging occurs, the position of the antenna in the watershed, flow conditions, and other factors that influence fish behavior. Assumptions are also made that detections are of live specimens of the target species, and not tags that have been expelled and are mobile in the system or are in the digestive system of a predatory species.

*Upper Penitencia Creek Antenna - Stationary*

The antenna was installed on Upper Penitencia Creek just below the perennial reaches on September 18, 2020 for the second season of monitoring. An antenna was also operated at this location during the 2019/2020 migration season. The antenna was a swim-through design, using a static line affixed to a tree on the north-east bank and a T-post on the south-east bank as the top wire support, and metal stakes in the substrate to maintain contact with the bottom of the channel (Figure 4). The antenna wire was connected to the static line and stakes in the bottom of the channel with plastic zip-ties. Care was taken to avoid direct contact between the metal stakes, T-post, and the antenna wire. The dimensions were 10.8 m long by 0.67 m high. The antenna array was created with a single loop of 10 American Wire Gauge (AWG) copper wire. The braided wire between the antenna and tuning box was 4.8 m in length. The twinax cable connecting the tuning box to the reader was 18.7 m in length. The antenna was connected to direct AC power for the duration of the 2020-2021 season. The antenna was powered by a 120-volt wired receptacle and connected to a 12-volt power inverter.

The antenna provided complete lateral coverage of the channel during most flows, but during large storm events if the floodplain inundated the channel margins would not receive coverage. There were no storm events in the 2020/2021 migration season large enough for this scenario to occur. No antenna outages occurred during the period of operation. The read-range consistently spanned the entire height of the antenna between the top and bottom wires for both the 23 mm and 12 mm tags. The read-range

up- and downstream of the antenna was typically 2 cm and 16 cm for the 12 mm and the 23 mm tag, respectively. The antenna was powered down on June 01, 2021.

Figure 4. Swim-through antenna on Upper Penitencia Creek, photographed when stream was dry. Arrow indicates top wire in the loop.

*Upper Penitencia Creek Antenna – Submersible*

The Biomark submersible antenna is a 3-foot diameter rigid circular antenna, a Bluetooth-enabled PIT reader, and a battery pack (four 180Ah, 3.2-volt lithium batteries) (Figure 5). The antenna is designed to provide up to 35 days of continuous operation on a single battery pack. The antenna has a storage capacity of up to one million records.

The submersible antenna was installed in Upper Penitencia creek on February 24, 2021. The antenna was located within Alum Rock Park, approximately 30.5 meters upstream of the bridge connecting the Mineral Springs Parking Lot to the Youth Science Institute. The read-range up- and downstream of the antenna for a 12 mm and 23 mm tag was approximately 30 cm and 58 cm, respectively. The width of the stream in this

location is narrow enough that the antenna provided full lateral coverage of the channel at the flows experienced during operation. The antenna was anchored to a T-post on the north bank and an existing flat head anchor in the creek on the south-side. The antenna was secured to the substrate using T-posts, coated cable, and rocks to keep the antenna fully submerged (Figure 6).

Data was downloaded once a month via Bluetooth connection in the field and stored on a portable tablet. No outages occurred at this antenna. The antenna was removed on May 23, 2021.

Figure 5.Biomark submersible antenna with reader, antenna, and battery pack attached.

Figure 6. Biomark submersible antenna submerged onsite in Upper Penitencia Creek.

*Lower Coyote Creek Antenna - Stationary*

FISHBIO was contracted by Valley Water to install and maintain the Coyote Creek antenna. The Coyote Creek antenna, located within the city limits of Milpitas in the lower reaches of Coyote Creek, was turned on December 21, 2021. This antenna is positioned downstream of the confluence of Upper Penitencia Creek, which provides the ability to detect outmigrants from Coyote Creek, as well as from the Upper

Penitencia creek sub-watershed. The antenna was constructed with two loops of 10 AWG. The loops were enclosed and separated by two 1.9 cm PVC pipes fitted within a 5.8 cm PVC pipe (Figure 7). The antenna measured 6.7 m wide by 0.6 m high and was constructed as a swim-through design (Figure 8). The antenna was secured with red head concrete anchors driven into the banks and along the channel bottom. Plastic zip-ties and bolts were used to secure the lower portion of the antenna to the substrate and sandbags were placed along the bottom antenna wire to secure it further. A stainless-steel cable was stretched across the channel and anchored to either bank and attached to the top of the PVC pipes with hose clamps and plastic zip-ties to hold the shape of the top of the antenna during high flows. The tuner was buried in the bank and covered with riprap approximately 1.2 meters from the antenna (Jack Eschenroeder (FISHBIO), personal communication). The antenna was powered by two pole-mounted 300-watt solar panels and a Victron Energy charge controller connected to four 6-volt batteries. The distance between the reader and the tuner was approximately 21 meters (Jack Eschenroeder (FISHBIO), personal communication). The read range for 12 mm PIT tags was approximately 30 cm upstream of the antenna and 46 cm downstream. An exact read range for 23 mm PIT tags was not recorded, but it was estimated that 12 mm tags were detected up to 30 cm both upstream and downstream of the antenna once it was fully operational (Jack Eschenroder (FISHBIO), personal communication).

On February 24, 2021 the antenna was moved downstream approximately 4.6 meters to mitigate interference with the USGS gauging station (11172175) (Figure 8). The construction of the antenna remained the same in the new location but could not be secured to the bottom of the channel as there was no concrete to anchor to. A gap of 15 to 30 cm could be created between the channel substrate and the bottom of the anchor depending on flow. A read-range test at the second location was not conducted for a 23 mm tag but the 12mm tag was detected at approximately 30 cm in all directions.

Figure 7. Nested PVC housing for double-looped lower Coyote Creek antenna at Highway 237.

Figure 8. Lower Coyote Creek swim-through antenna at location two. Photo taken in early June 2021 after the antenna was powered down for the season.

The antenna provided nearly 100% coverage of the channel under base flow conditions. There was a distance of 0.3 to 0.6 meters on either side of the antenna and the respective bank that was not covered by the antenna array, but these areas were shallow and largely blocked by large pieces of grouted riprap and rock on either side of the channel. During periods of high flow (>100 cfs) this area would have enlarged to create a gap around either side of the antenna. Flows exceeded 100 cfs for four days in January from the 27 to the 31 and for a portion of March 06.  After the antenna was relocated it is possible that fish were able to swim under the antenna. The read range under the antenna was not tested at the new location to determine if fish passing under the antenna would be detected. There were no outages of the antenna during the monitoring season; however, in periods of higher flow it is anticipated that antenna

efficiency decreased (FISHBIO, personal communication). The antenna was powered down for the monitoring season on June 1, 2021.

# 3. Results

## 3.1 Upper Penitencia Creek Antennas

No PIT tags were detected during the 2020-2021 monitoring season on either the submersible or stationary antenna on Upper Penitencia Creek. There were no outages recorded at any antenna in the Coyote Creek Watershed for the duration of the monitoring period.

Due to the extreme drought conditions, flows in Upper Penitencia Creek provided limited opportunity for juvenile *O. mykiss* passage to Coyote Creek in the 2020-2021 migration season (Figure 9). Three storm events occurred during 2020/2021 that may have provoked migration though no detections were recorded on any antenna (Figure 9).

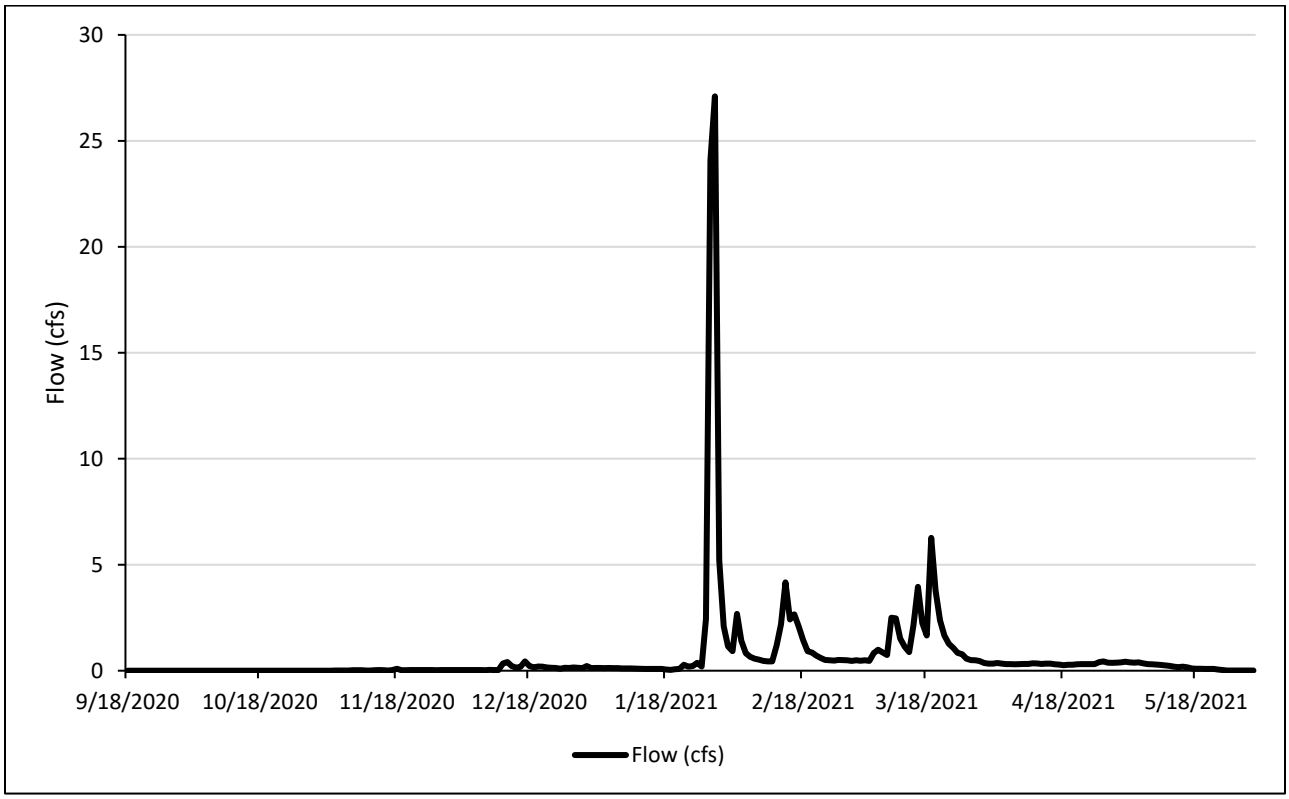


Figure 9. Average daily flow (cfs) on Upper Penitencia Creek at Dorel Drive stream gage (ALERT ID 5083.1).

### 3.2 Lower Coyote Creek Antenna

No *O. mykiss* were detected at the lower Coyote Creek antenna during the 2020-2021 season. The Coyote Creek antenna did not provide complete coverage during high flow events, so some tagged fish could have avoided detection. One period of high daily average flow (>700 cfs) occurred in late January; during this time, fish moving or migrating out of the system could have avoided detection by the PIT antenna array (Figure 10).

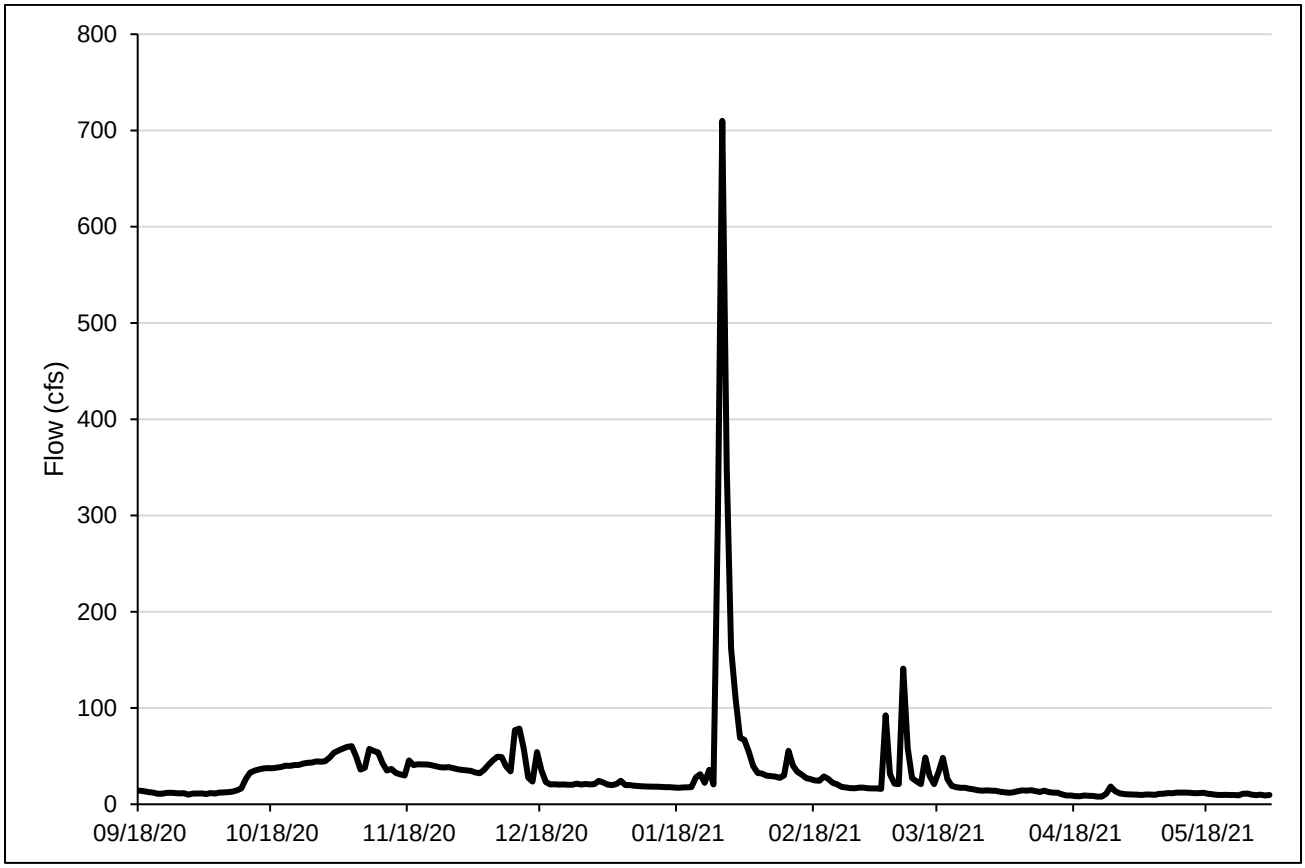


Figure 10. Daily average flow (cfs) on Coyote Creek at Highway 237 USGS gauge (11172175).

## 4. Discussion

No *O. mykiss* were detected on any of the three antennas within the Coyote Creek Watershed during the 2020-2021 monitoring season.

This effort represented the second season of PIT tag monitoring in the Coyote Creek Watershed. Minimal tagging occurred during the 2020-2021 season and extreme drought conditions limited migration opportunities.

The detections in 2019-2020 indicated some level of movement and likely migratory tendencies of fish from the Upper Penitencia Creek population (Valley Water 2021). Installation of the third submersible antenna in 2021 was undertaken to gain additional insight on movement within Alum Rock Park. A submersible antenna such as the one installed in Alum Rock Park is suitable for narrow streams in a secure location. Due to the lack of detections at all antennas in 2020-2021 more information is needed to determine the best location for additional submersible antenna deployment.

To date, no tags have been detected on the Highway 237 antenna. As this is only the second year of monitoring and extreme drought conditions and a small sample size were present in the 2020-2021 migration season, no conclusion can be drawn on the effectiveness of this antenna or migratory tendencies of Coyote Watershed *O. mykiss*. The antenna did function as intended and had a read range that could detect migrating tagged fish.

Despite the lack of detections in the 2020-2021 sampling season future tagging efforts will help to build more robust dataset in the Coyote Creek Watershed.

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# Appendix A

# PIT Tag Master List

| Date | Creek | Species | Weight (g) | Length (mm) | PIT ID (Decimal) |
|---|---|---|---|---|---|
| 12/16/2013 | Guadalupe River | O. mykiss | - | 134 | 982.000361656209 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 136 | 982.000361656215 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 155 | 982.000361656218 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 142 | 982.000361656222 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | - | 982.000361656226 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 129 | 982.000361656230 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 133 | 982.000361656235 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 163 | 982.000361656237 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 125 | 982.000361656243 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 172 | 982.000361656249 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 151 | 982.000361656258 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 110 | 982.000362992258 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 160 | 982.000361656260 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 129 | 982.000361656263 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 230 | 982.000361656267 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 118 | 982.000362992269 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 175 | 982.000361656269 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 144 | 982.000361656274 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 122 | 982.000361656277 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 142 | 982.000361656278 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 112 | 982.000362992279 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 149 | 982.000361656280 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 135 | 982.000361656294 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 106 | 982.000362992296 |
| 12/16/2013 | Guadalupe River | O. mykiss | - | 122 | 982.000362992356 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 135 | 982.000361656216 |
| 1/17/2014 | Los Gatos Creek | O. mykiss | - | 115 | 982.000361656217 |
| 1/17/2014 | Los Gatos Creek | O. mykiss | - | 164 | 982.000361656229 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 156 | 982.000361656238 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 133 | 982.000361656247 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 120 | 982.000361656250 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 115 | 982.000361656252 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 80 | 982.000362992263 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 190 | 982.000361656264 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 150 | 982.000361656265 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 104 | 982.000362992272 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 85 | 982.000362992278 |
| 1/17/2014 | Los Gatos Creek | O. mykiss | - | 142 | 982.000361656288 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 93 | 982.000362992289 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 79 | 982.000362992290 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 119 | 982.000361656290 |
| 1/17/2014 | Los Gatos Creek | O. mykiss | - | 126 | 982.000361656298 |
| 1/17/2014 | Los Gatos Creek | O. mykiss | - | 89 | 982.000362992298 |
| 1/17/2014 | Los Gatos Creek | O. mykiss | - | 138 | 982.000361656299 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 75 | 982.000362992302 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 110 | 982.000362992303 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 155 | 982.000361656305 |

| | | | | | |
|---|---|---|---|---|---|
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 91 | 982.000362992306 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 91 | 982.000362992312 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 92 | 982.000362992315 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 71 | 982.000362992325 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 102 | 982.000362992327 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 79 | 982.000362992328 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 80 | 982.000362992330 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 110 | 982.000362992333 |
| 1/17/2014 | Guadalupe Creek | O. mykiss | - | 69 | 982.000362992340 |
| 1/17/2014 | Guadalupe River | O. mykiss | - | 138 | 982.000361656521 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 148 | 982.000361656219 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 189 | 982.000361656225 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 149 | 982.000361656227 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 179 | 982.000361656231 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 147 | 982.000361656242 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 156 | 982.000361656244 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 132 | 982.000361656272 |
| 2/12/2014 | Guadalupe River | O. mykiss | - | 193 | 982.000361656291 |
| 2/21/2014 | Los Gatos Creek | O. mykiss | - | 116 | 982.000361656213 |
| 2/21/2014 | Los Gatos Creek | O. mykiss | - | 142 | 982.000361656270 |
| 2/21/2014 | Guadalupe River | O. mykiss | - | 145 | 982.000361656311 |
| 2/21/2014 | Los Gatos Creek | O. mykiss | - | 112 | 982.000361656454 |
| 3/14/2014 | Guadalupe River | O. mykiss | - | 153 | 982.000361654515 |
| 3/15/2014 | Pond A8 | striped bass | | 520 | 982.000362654458 |
| 3/15/2014 | Pond A8 | striped bass | | 500 | 982.000362654476 |
| 3/15/2014 | Pond A8 | striped bass | | 530 | 982.000362655000 |
| 3/15/2014 | Pond A8 | striped bass | | 500 | 982.000362654505 |
| 3/15/2014 | Pond A8 | striped bass | | 440 | 982.000362654514 |
| 3/15/2014 | Pond A8 | striped bass | | 470 | 982.000362654539 |
| 4/17/2014 | Pond A5 | Leopard Shark | - | 1219 | 982.000362654450 |
| 4/17/2014 | Pond A5 | Leopard Shark | - | 838 | 982.000362654453 |
| 4/17/2014 | Pond A5 | Leopard Shark | - | 864 | 982.000362654461 |
| 4/17/2014 | Pond A5 | Leopard Shark | - | 914 | 982.000362654494 |
| 4/17/2014 | Pond A5 | Leopard Shark | - | 864 | 982.000362654521 |
| 4/17/2014 | Pond A5 | Leopard Shark | - | 889 | 982.000362654528 |
| 4/17/2014 | Pond A8 | striped bass | | 737 | 982.000362654448 |
| 4/17/2014 | Pond A8 | striped bass | | 762 | 982.000362654460 |
| 4/17/2014 | Pond A8 | striped bass | | 660 | 982.000362654466 |
| 4/17/2014 | Pond A8 | striped bass | | 787 | 982.000362654467 |
| 4/17/2014 | Pond A8 | striped bass | | 330 | 982.000362655150 |
| 4/17/2014 | Pond A8 | striped bass | | 762 | 982.000362654524 |
| 4/17/2014 | Pond A8 | striped bass | | 965 | 982.000362654529 |
| 4/17/2014 | Pond A8 | striped bass | | 305 | 982.000362654534 |
| 4/17/2014 | Pond A8 | striped bass | | 305 | 982.000362654537 |
| 4/17/2014 | Pond A8 | striped bass | | 838 | 982.000362654540 |
| 4/17/2014 | Pond A8 | striped bass | | 508 | 982.000362654543 |
| 10/19/2014 | Alamitos Creek | O. mykiss | | 105 | 982.000362992262 |
| 10/19/2014 | Alamitos Creek | O. mykiss | | 98 | 982.0003629923 |

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|---|---|---|---|---|---|
| 10/19/2014 | Guadalupe Creek | O. mykiss | | 110 | 982.000362992288 |
| 10/19/2014 | Guadalupe Creek | O. mykiss | | 110 | 982.000362992271 |
| 10/19/2014 | Guadalupe Creek | O. mykiss | | 65 | 982.000362992351 |
| 10/19/2014 | Guadalupe Creek | O. mykiss | | 110 | 982.000362992281 |
| 10/19/2014 | Guadalupe Creek | O. mykiss | | 90 | 982.000362992331 |
| 10/19/2014 | Guadalupe Creek | O. mykiss | | 81 | 982.000362992285 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 146 | 982.000362655573 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 100 | 982.000362992305 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 117 | 982.000362992280 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 173 | 982.000362654463 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 124 | 982.000362654546 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 86 | 982.000362992307 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 67 | 982.000362992342 |
| 11/2/2014 | Guadalupe Creek | O. mykiss | | 96 | 982.000362654480 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | NA | 982.000360826977 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 93 | 982.000362992308 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 85 | 982.000360826958 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 72 | 982.000362992287 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 123 | 982.000362655643 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 120 | 982.000362655612 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 78 | 982.000362992353 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 139 | 982.000362655554 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 168 | 982.000362655626 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 72 | 982.000362992295 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 65 | 982.000362992317 |
| 11/3/2014 | Guadalupe Creek | O. mykiss | | 88 | 982.000362992310 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 43.06 | 146 | 900.226000319370 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 15.14 | 111 | 900.226000319353 |
| 9/17/2018 | Alamitos Creek | O. mykiss | - | 199 | 900.226000319320 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 17.2 | 109 | 900.226000319322 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 13.3 | 102 | 900.226000319339 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 15.09 | 107 | 900.226000319313 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 8.33 | 89 | 900.226000319367 |
| 9/17/2018 | Alamitos Creek | O. mykiss | - | 248 | 900.226000319355 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 12.92 | 103 | 900.226000319350 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 21.42 | 119 | 900.226000319366 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 19.34 | 117 | 900.226000319375 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 16.51 | 111 | 900.226000319326 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 23.78 | 122 | 900.226000319387 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 26.74 | 132 | 900.226000319376 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 30.42 | 141 | 900.226000319319 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 32.1 | 136 | 900.226000319352 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 13.3 | 103 | 900.226000319314 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 32.7 | 138 | 900.226000319391 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 25.26 | 129 | 900.226000319310 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 11.5 | 97 | 900.226000319372 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 81.27 | 186 | 900.226000319301 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 19.01 | 117 | 900.226000319384 |

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|---|---|---|---|---|---|
| 9/17/2018 | Alamitos Creek | O. mykiss | 14.39 | 104 | 900.226000319316 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 11.97 | 102 | 900.226000319397 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 10 | 95 | 900.226000319388 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 14.48 | 106 | 900.226000319360 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 18.58 | 115 | 900.226000319321 |
| 9/17/2018 | Alamitos Creek | O. mykiss | 23.03 | 122 | 900.226000319348 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 7.81 | 83 | 900.226000319227 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 9.25 | 87 | 900.226000319276 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 14.28 | 106 | 900.226000319293 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 4.75 | 67 | 900.226000319318 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 4.62 | 72 | 900.226000319305 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 3.72 | 66 | 900.226000319334 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 6.37 | 72 | 900.226000319341 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 3.58 | 65 | 900.226000319308 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 31.33 | 138 | 900.226000319389 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 6.82 | 81 | 900.226000319385 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 4.58 | 66 | 900.226000319338 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 5.32 | 74 | 900.226000319324 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 6.93 | 86 | 900.226000319364 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 6.66 | 79 | 900.226000319345 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 8.33 | 84 | 900.226000319358 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 6.12 | 76 | 900.226000319329 |
| 10/16/2018 | Guadalupe Creek | O. mykiss | 4.97 | 70 | 900.226000319351 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.62 | 75 | 900.226000319346 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.22 | 66 | 900.226000319394 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 6.02 | 79 | 900.226000319386 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.9 | 77 | 900.226000319340 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.52 | 70 | 900.226000319317 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.14 | 72 | 900.226000319337 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 8.05 | 86 | 900.226000319344 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.23 | 68 | 900.226000319330 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 6.06 | 75 | 900.226000319307 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.08 | 67 | 900.226000319309 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 3.83 | 65 | 900.226000319333 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.66 | 74 | 900.226000319361 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 96.04 | 199 | 900.228000613702 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.61 | 65 | 900.226000319381 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 6.62 | 76 | 900.226000319342 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.35 | 66 | 900.226000319399 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.63 | 70 | 900.226000319377 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.68 | 72 | 900.226000319371 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 6.23 | 75 | 900.226000319395 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.95 | 69 | 900.226000319325 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 6.2 | 78 | 900.226000319356 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 6.22 | 79 | 900.226000319374 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.36 | 69 | 900.226000319379 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 4.53 | 67 | 900.226000319354 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 18.15 | 112 | 900.226000319328 |

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|---|---|---|---|---|---|
| 10/17/2018 | Guadalupe Creek | O. mykiss | 3.85 | 68 | 900.226000319393 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.05 | 79 | 900.226000319327 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.23 | 74 | 900.226000319362 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 11.22 | 90 | 900.226000319304 |
| 10/17/2018 | Guadalupe Creek | O. mykiss | 5.31 | 74 | 900.226000319398 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 5.35 | 68 | 900.226000319284 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 4.23 | 66 | 900.226000319260 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 4.35 | 65 | 900.226000319291 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 3.25 | 65 | 900.226000319292 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 4.86 | 69 | 900.226000319295 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 20.6 | 125 | 900.226000319250 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 17.5 | 109 | 900.226000319246 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 36.5 | 145 | 900.226000319258 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 14.8 | 79 | 900.226000319263 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 24.9 | 109 | 900.226000319201 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 12.5 | 94 | 900.226000319218 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 18.6 | 106 | 900.226000319269 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 20.2 | 111 | 900.226000319200 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 19 | 108 | 900.226000319311 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 42.3 | 146 | 900.226000319257 |
| 10/18/2018 | Alamitos Creek | O. mykiss | 16.8 | 110 | 900.226000319290 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 7.7 | 84 | 900.226000319343 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 13.8 | 98 | 900.226000319306 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 13 | 100 | 900.226000319349 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 9.6 | 91 | 900.226000319312 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 14.1 | 102 | 900.226000319315 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 12.8 | 103 | 900.226000319382 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 10 | 91 | 900.226000319365 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 445 | 345 | 900.228000613703 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 9.4 | 92 | 900.226000319363 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 10.2 | 90 | 900.226000319390 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 23 | 119 | 900.226000319378 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 25.1 | 115 | 900.226000319396 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 20.8 | 117 | 900.226000319368 |
| 10/22/2018 | Alamitos Creek | O. mykiss | 28.2 | 129 | 900.226000319380 |
| 10/23/2018 | Calero Creek | O. mykiss | 215.3 | 263 | 900.228000613704 |
| 10/23/2018 | Calero Creek | O. mykiss | 7.5 | 82 | 900.226000319280 |
| 10/23/2018 | Calero Creek | O. mykiss | 125.2 | 216 | 900.228000613705 |
| 10/23/2018 | Calero Creek | O. mykiss | 14.3 | 109 | 900.226000319268 |
| 10/23/2018 | Calero Creek | O. mykiss | 11.5 | 95 | 900.226000319336 |
| 10/23/2018 | Calero Creek | O. mykiss | 7.3 | 82 | 900.226000319302 |
| 10/23/2018 | Calero Creek | O. mykiss | 10.1 | 89 | 900.226000319332 |
| 10/23/2018 | Calero Creek | O. mykiss | 5.2 | 67 | 900.226000319373 |
| 10/24/2018 | Calero Creek | O. mykiss | 9.3 | 84 | 900.226000319357 |
| 10/24/2018 | Calero Creek | O. mykiss | 7.8 | 84 | 900.226000319347 |
| 10/24/2018 | Calero Creek | O. mykiss | 5.4 | 75 | 900.226000319323 |
| 10/24/2018 | Calero Creek | O. mykiss | 10.4 | 86 | 900.226000319300 |
| 10/24/2018 | Calero Creek | O. mykiss | 8.5 | 85 | 900.226000319231 |

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|---|---|---|---|---|---|
| 10/24/2018 | Calero Creek | O. mykiss | 12.5 | 94 | 900.226000319244 |
| 10/24/2018 | Calero Creek | O. mykiss | 8.3 | 82 | 900.226000319287 |
| 10/24/2018 | Calero Creek | O. mykiss | 10.2 | 93 | 900.226000319230 |
| 10/24/2018 | Calero Creek | O. mykiss | 9.4 | 86 | 900.226000319212 |
| 11/6/2018 | Guadalupe Creek | O. mykiss | 12.4 | 95 | 900.226000319294 |
| 11/6/2018 | Guadalupe Creek | O. mykiss | 8.7 | 87 | 900.226000319214 |
| 11/6/2018 | Guadalupe Creek | O. mykiss | 18.2 | 116 | 900.226000319278 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 5.73 | 75 | 900.228000613710 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 6.6 | 84 | 900.226000319233 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 9.5 | 88 | 900.226000319239 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 7.1 | 81 | 900.226000319210 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 152.1 | 234 | 900.228000613711 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 5.1 | 71 | 900.226000319209 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 5.8 | 77 | 900.226000319277 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 9.6 | 85 | 900.226000319220 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 53.6 | 168 | 900.228000613712 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 14.7 | 104 | 900.226000319222 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 8.6 | 84 | 900.226000319228 |
| 10/9/2019 | Guadalupe Creek | O. mykiss | 8.0 | 76 | 900.226000319237 |
| 10/10/2019 | Alamitos Creek | O. mykiss | 11.4 | 95 | 900.226000319265 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 8.6 | 82 | 900.226000319288 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 8.6 | 86 | 900.226000319208 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 9.4 | 89 | 900.226000319252 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 3.4 | 66 | 900.226000319369 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 7.9 | 85 | 900.226000319249 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 41.7 | 150 | 900.226000319215 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 16.3 | 106 | 900.226000319204 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 6.5 | 82 | 900.226000319296 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 14.3 | 99 | 900.226000319261 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 7.1 | 81 | 900.226000319206 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 10.2 | 91 | 900.226000319242 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 7.7 | 81 | 900.226000319219 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 9.5 | 89 | 900.226000319216 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 10.4 | 91 | 900.226000319281 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 12.3 | 100 | 900.226000319217 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 16.5 | 107 | 900.226000319272 |
| 10/10/2019 | Guadalupe Creek | O. mykiss | 13.4 | 104 | 900.226000319247 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 7.9 | 83 | 900.226000319254 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 11.5 | 87 | 900.226000319203 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 5.5 | 75 | 900.226000319205 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 3.3 | 65 | 900.226000319225 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 3.9 | 68 | 900.226000319282 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 4.9 | 71 | 900.226000319224 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 5.7 | 76 | 900.226000319248 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 13.9 | 105 | 900.226000319221 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 5.3 | 72 | 900.226000319226 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 4.1 | 68 | 900.226000319202 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 4.8 | 69 | 900.226000319223 |

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|---|---|---|---|---|---|
| 10/23/2019 | Alamitos Creek | O. mykiss | 14.4 | 105 | 900.226000319236 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 4.7 | 67 | 900.226000319240 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 22.9 | 122 | 900.226000319274 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 5.2 | 73 | 900.226000319283 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 10.7 | 90 | 900.226000319273 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 15.1 | 106 | 900.226000319256 |
| 10/23/2019 | Alamitos Creek | O. mykiss | 9.0 | 88 | 900.226000319211 |
| 10/28/2019 | Calero Creek | O. mykiss | 250.1 | 280 | 900.228000613713 |
| 10/28/2019 | Calero Creek | O. mykiss | 7.9 | 85 | 900.226000319259 |
| 10/28/2019 | Calero Creek | O. mykiss | 6.6 | 81 | 900.226000319297 |
| 10/28/2019 | Calero Creek | O. mykiss | 12.4 | 96 | 900.226000319285 |
| 10/28/2019 | Calero Creek | O. mykiss | 14.6 | 107 | 900.226000319286 |
| 10/28/2019 | Calero Creek | O. mykiss | 12.3 | 95 | 900.226000319207 |
| 10/28/2019 | Calero Creek | O. mykiss | 8.5 | 86 | 900.226000319245 |
| 10/30/2019 | Guadalupe River | O. mykiss | 169.6 | 248 | 900.228000613714 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 7.0 | 81 | 900.226000319270 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 12.2 | 99 | 900.226000319232 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 28.8 | 134 | 900.226000319213 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 11.7 | 95 | 900.226000319241 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 5.8 | 75 | 900.226000319267 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 10.7 | 90 | 900.226000319298 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 6.3 | 76 | 900.226000319299 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 13.4 | 98 | 900.226000319234 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 11.6 | 93 | 900.226000319271 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 11.5 | 95 | 900.226000319238 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 11.9 | 99 | 900.226000319255 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 8.5 | 90 | 900.226000319251 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 15.9 | 103 | 900.226000319262 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 25.4 | 130 | 900.226000319253 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 12.0 | 96 | 900.226000319229 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 14.1 | 97 | 900.226000319275 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 20.2 | 115 | 900.226000319279 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 33.6 | 140 | 982.126058146080 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 18.9 | 112 | 982.126058146069 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 19.5 | 117 | 982.126058146081 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 15.1 | 105 | 982.126058146089 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 6.6 | 80 | 982.126058146053 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 65.4 | 173 | 900.228000613716 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 281.8 | 280 | 900.228000613715 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 60.3 | 170 | 900.228000613718 |
| 10/31/2019 | Alamitos Creek | O. mykiss | 40.1 | 150 | 900.228000613717 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.2 | 74 | 982.126058146054 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 6.0 | 76 | 982.126058146126 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 7.0 | 79 | 982.126058146101 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 9.3 | 89 | 982.126058146077 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 75.1 | 189 | 900.228000613719 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 17.8 | 111 | 982.126058146117 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 15.1 | 108 | 982.126058146065 |

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| 11/4/2019 | Upper Penitencia | O. mykiss | 9.9 | 94 | 982.126058146106 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 9.1 | 88 | 982.126058146036 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 96.5 | 209 | 900.228000613720 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 151.3 | 236 | 900.228000613721 |
| 11/4/2019 | Upper Penitencia | O. mykiss | - | - | 900.228000613722 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 12.4 | 97 | 982.126058146093 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 7.8 | 85 | 982.126058146039 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 11.3 | 93 | 982.126058146070 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 63.9 | 177 | 900.228000613723 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.1 | 74 | 982.126058146083 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 59.4 | 178 | 900.228000613724 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 13.8 | 105 | 982.126058146067 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 8.5 | 84 | 982.126058146084 |
| 11/4/2019 | Upper Penitencia | O. mykiss | - | 79 | 982.126058146042 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 24.1 | 130 | 982.126058146043 |
| 11/4/2019 | Upper Penitencia | O. mykiss | - | 106 | 982.126058146105 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 12 | 92 | 982.126058146111 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 4.5 | 73 | 982.126058146044 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 7.6 | 84 | 982.126058146100 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 17.3 | 108 | 982.126058146116 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 48.2 | 162 | 900.228000613726 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 10.8 | 92 | 982.126058146058 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 41.1 | 158 | 900.228000613727 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 8.7 | 91 | 982.126058146085 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.2 | 73 | 982.126058146095 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 7.2 | 85 | 982.126058146103 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 15.5 | 103 | 982.126058146046 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 10.7 | 100 | 982.126058146074 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.8 | 78 | 982.126058146076 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 41.9 | 156 | 900.228000613728 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 38.6 | 145 | 982.126058146034 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 49.2 | 162 | 900.228000613730 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 12.5 | 101 | 982.126058146096 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 6.2 | 78 | 982.126058146055 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 13.3 | 96 | 982.126058146033 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 8.7 | 88 | 982.126058146037 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 6.9 | 83 | 982.126058146063 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 13.1 | 102 | 982.126058146071 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 143.1 | 234 | 900.228000613729 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.8 | 75 | 982.126058146129 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 19.7 | 112 | 982.126058146064 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 55.3 | 172 | 900.228000613731 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 11.5 | 98 | 982.126058146079 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 19.2 | 112 | 982.126058146068 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 6.2 | 79 | 982.126058146092 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 7.9 | 86 | 982.126058146056 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.3 | 77 | 982.126058146087 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 6.3 | 81 | 982.126058146048 |

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| 11/4/2019 | Upper Penitencia | O. mykiss | 8.7 | 90 | 982.126058146062 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 6.3 | 78 | 982.126058146041 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 13.9 | 101 | 982.126058146098 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.5 | 77 | 982.126058146113 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 5.1 | 74 | 982.126058146115 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 8.6 | 90 | 982.126058146088 |
| 11/4/2019 | Upper Penitencia | O. mykiss | 171.5 | 245 | 900.228000613732 |
| 11/6/2019 | Coyote Creek | O. mykiss | 18.1 | 112 | 982.126058146078 |
| 11/6/2019 | Coyote Creek | O. mykiss | 23.2 | 122 | 982.126058146114 |
| 11/6/2019 | Coyote Creek | O. mykiss | 28.2 | 133 | 982.126058146107 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 31.8 | 141 | 982.126058146110 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 10.6 | 95 | 982.126058146131 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 38.8 | 153 | 900.228000613734 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 24.8 | 128 | 982.126058146118 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 20.4 | 125 | 982.126058146082 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 58.2 | 172 | 900.228000613735 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 54.7 | 168 | 900.228000613736 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 35.2 | 149 | 982.126058146075 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 147.8 | 238 | 900.228000613738 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 46.3 | 159 | 900.228000613739 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 23.5 | 124 | 982.126058146102 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 96.5 | 204 | 900.228000613737 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 68.9 | 184 | 900.228000613740 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 119.5 | 224 | 900.228000613742 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 7.5 | 84 | 982.126058146051 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 7.5 | 86 | 982.126058146038 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 30.5 | 140 | 982.126058146123 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 9.8 | 88 | 982.126058146057 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 12.2 | 97 | 982.126058146032 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 8.7 | 80 | 982.126058146073 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 23.6 | 125 | 982.126058146047 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 15.7 | 94 | 982.126058146122 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 13.8 | 94 | 982.126058146049 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 9.1 | 86 | 982.126058146109 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 8.8 | 84 | 982.126058146052 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 24.5 | 124 | 982.126058146099 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 26.3 | 128 | 982.126058146128 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 73.5 | 184 | 900.228000613743 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 38.5 | 134 | 982.126058146124 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 2.9 | 84 | 982.126058146045 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 110.3 | 209 | 900.228000613744 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 28.9 | 132 | 982.126058146108 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 12.4 | 96 | 982.126058146090 |
| 11/13/2019 | Upper Penitencia | O. mykiss | 37.2 | 154 | 982.126058146059 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 38.2 | 147 | 982.126058146943 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | | 144 | 982.126058146121 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 25.4 | 129 | 982.126058146947 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 22.2 | 121 | 982.126058146948 |

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| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 39.3 | 152 | 900.228000613803 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 59.1 | 178 | 900.228000613802 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 124 | 237 | 900.228000613804 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 31.5 | 142 | 982.126058146963 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 36.1 | 151 | 900.228000613801 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 79.4 | 196 | 900.228000613806 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | | 104 | 982.126058146086 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | 26.4 | 130 | 982.126058146954 |
| 8/4/2020 | Upper Penitencia Creek | O. mykiss | | 123 | 982.126058146066 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 3.9 | 67 | 982.126058146127 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 6.4 | 78 | 982.126058146094 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 4.1 | 71 | 982.126058146060 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 59.7 | 184 | 900.228000613747 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 5.8 | 82 | 982.126058146130 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 8.1 | 83 | 982.126058146119 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 10.5 | 97 | 982.126058146050 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 17.5 | 118 | 982.126058146061 |
| 10/21/2020 | Guadalupe Creek | O. mykiss | 11.2 | 99 | 982.126058146104 |
| 10/22/2020 | Guadalupe Creek | O. mykiss | 4.5 | 71 | 982.126058146072 |
| 10/28/2020 | Stevens Creek | O. mykiss | 21 | 122 | 982.126058146870 |
| 10/28/2020 | Stevens Creek | O. mykiss | 15.1 | 105 | 982.126058146097 |
| 10/28/2020 | Stevens Creek | O. mykiss | 24.2 | 125 | 982.126058146872 |
| 10/28/2020 | Stevens Creek | O. mykiss | 34.5 | 146 | 982.126058146923 |
| 10/28/2020 | Stevens Creek | O. mykiss | 4.4 | 68 | 982.126058146881 |
| 10/28/2020 | Stevens Creek | O. mykiss | 15.6 | 103 | 982.126058146902 |
| 10/28/2020 | Stevens Creek | O. mykiss | 48.5 | 162 | 900.228000613748 |
| 10/28/2020 | Stevens Creek | O. mykiss | 4.8 | 70 | 982.126058146867 |
| 10/28/2020 | Stevens Creek | O. mykiss | 3.8 | 69 | 982.126058146909 |
| 10/28/2020 | Stevens Creek | O. mykiss | 4.3 | 69 | 982.126058146926 |
| 10/28/2020 | Stevens Creek | O. mykiss | 4.5 | 69 | 982.126058146911 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.6 | 66 | 982.126058146903 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.8 | 69 | 982.126058146908 |
| 10/29/2020 | Stevens Creek | O. mykiss | 3.9 | 68 | 982.126058146927 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.1 | 68 | 982.126058146919 |
| 10/29/2020 | Stevens Creek | O. mykiss | 3.3 | 67 | 982.126058146891 |
| 10/29/2020 | Stevens Creek | O. mykiss | 5.1 | 71 | 982.126058146913 |
| 10/29/2020 | Stevens Creek | O. mykiss | 6.1 | 75 | 982.126058146914 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.4 | 71 | 982.126058146892 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.5 | 69 | 982.126058146890 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.4 | 69 | 982.126058146861 |
| 10/29/2020 | Stevens Creek | O. mykiss | 6.6 | 78 | 982.126058146875 |
| 10/29/2020 | Stevens Creek | O. mykiss | 6.2 | 78 | 982.126058146920 |
| 10/29/2020 | Stevens Creek | O. mykiss | 13.1 | 100 | 982.126058146874 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.3 | 65 | 982.126058146899 |
| 10/29/2020 | Stevens Creek | O. mykiss | 34.6 | 141 | 982.126058146900 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.2 | 72 | 982.126058146858 |
| 10/29/2020 | Stevens Creek | O. mykiss | 8.6 | 82 | 982.126058146924 |
| 10/29/2020 | Stevens Creek | O. mykiss | 9.5 | 88 | 982.126058146888 |

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| 10/29/2020 | Stevens Creek | O. mykiss | 4.9 | 74 | 982.126058146922 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.9 | 71 | 982.126058146931 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.2 | 70 | 982.126058146918 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.4 | 67 | 982.126058146925 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.8 | 70 | 982.126058146886 |
| 10/29/2020 | Stevens Creek | O. mykiss | 4.4 | 71 | 982.126058146897 |
| 10/29/2020 | Stevens Creek | O. mykiss | 5 | 71 | 982.126058146921 |
| 10/29/2020 | Stevens Creek | O. mykiss | 3.7 | 69 | 982.126058146928 |
| 11/2/2020 | Calero Creek | O. mykiss | 5.2 | 74 | 982.126058146917 |
| 11/2/2020 | Calero Creek | O. mykiss | 7.4 | 86 | 982.126058146847 |
| 11/2/2020 | Calero Creek | O. mykiss | 3.7 | 66 | 982.126058146876 |
| 11/2/2020 | Calero Creek | O. mykiss | 3.8 | 68 | 982.126058146850 |
| 11/2/2020 | Calero Creek | O. mykiss | 8.9 | 87 | 982.126058146869 |
| 11/2/2020 | Calero Creek | O. mykiss | 5.1 | 70 | 982.126058146859 |
| 11/2/2020 | Calero Creek | O. mykiss | 2.9 | 66 | 982.126058146894 |
| 11/2/2020 | Calero Creek | O. mykiss | 5.8 | 81 | 982.126058146841 |
| 11/2/2020 | Calero Creek | O. mykiss | 6.2 | 76 | 982.1.6058146889 |
| 11/2/2020 | Calero Creek | O. mykiss | 12.9 | 99 | 982.126058146860 |
| 11/2/2020 | Calero Creek | O. mykiss | 7.6 | 86 | 982.126058146849 |
| 11/2/2020 | Calero Creek | O. mykiss | 4.9 | 72 | 982.126058146856 |
| 11/2/2020 | Calero Creek | O. mykiss | 6.5 | 81 | 982.126058146845 |
| 11/2/2020 | Calero Creek | O. mykiss | 7.1 | 84 | 982.126058146904 |
| 11/2/2020 | Calero Creek | O. mykiss | 11.3 | 97 | 982.126058146834 |
| 11/2/2020 | Calero Creek | O. mykiss | 4.6 | 73 | 982.126058146863 |
| 11/2/2020 | Calero Creek | O. mykiss | 9.1 | 90 | 982.126058146901 |
| 11/2/2020 | Calero Creek | O. mykiss | 11 | 96 | 982.126058146896 |
| 11/2/2020 | Calero Creek | O. mykiss | 295.5 | 290 | 900.228000613749 |
| 11/2/2020 | Calero Creek | O. mykiss | 3.6 | 66 | 982.126058146910 |
| 11/2/2020 | Calero Creek | O. mykiss | 3.9 | 67 | 982.126058146871 |
| 11/2/2020 | Calero Creek | O. mykiss | 5.3 | 75 | 982.126058146912 |
| 11/2/2020 | Calero Creek | O. mykiss | 4.1 | 71 | 982.126058146893 |
| 11/2/2020 | Calero Creek | O. mykiss | 6.7 | 82 | 982.126058146833 |
| 11/2/2020 | Calero Creek | O. mykiss | 4.8 | 71 | 982.126058146906 |
| 11/2/2020 | Calero Creek | O. mykiss | 4 | 70 | 982.126058146915 |
| 11/2/2020 | Calero Creek | O. mykiss | 7.2 | 81 | 982.126058146930 |
| 11/2/2020 | Calero Creek | O. mykiss | 8.5 | 88 | 982.126058146862 |
| 11/2/2020 | Calero Creek | O. mykiss | 5.7 | 73 | 982.126058146884 |
| 11/2/2020 | Calero Creek | O. mykiss | 5.5 | 79 | 982.126058146887 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 157.8 | 239 | 900.228000613750 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 26.1 | 133 | 982.126058146864 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 14.6 | 94 | 982.126058146879 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 16.5 | 103 | 982.126058146898 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 19.4 | 106 | 982.126058146873 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 16.2 | 111 | 982.126058146851 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 162.5 | 240 | 900.228000613752 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 80 | 192 | 900.228000613751 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 25.8 | 125 | 982.126058146929 |
| 11/9/2020 | Alamitos Creek | O. mykiss | 27.8 | 138 | 982.126058146854 |

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| 11/9/2020 | Alamitos Creek | O. mykiss | 9.8 | 95 | 982.126058146857 |
| 11/10/2020 | Alamitos Creek | O. mykiss | 19.7 | 123 | 982.126058146838 |
| 11/10/2020 | Alamitos Creek | O. mykiss | 6.6 | 79 | 982.126058146832 |
| 11/10/2020 | Alamitos Creek | O. mykiss | 15.4 | 117 | 982.126058146916 |
| 11/10/2020 | Alamitos Creek | O. mykiss | 23.1 | 132 | 982.126058146852 |
| 11/10/2020 | Alamitos Creek | O. mykiss | 25.9 | 136 | 982.126058146868 |
| 11/12/2020 | Alamitos Creek | O. mykiss | 29.7 | 135 | 982.126058146853 |
| 11/12/2020 | Alamitos Creek | O. mykiss | 23.7 | 129 | 982.126058146839 |
| 11/12/2020 | Alamitos Creek | O. mykiss | 9.8 | 90 | 982.126058146843 |
| 11/12/2020 | Alamitos Creek | O. mykiss | 20.1 | 113 | 982.126058146877 |
| 11/12/2020 | Alamitos Creek | O. mykiss | 31.5 | 133 | 982.126058146836 |
| 11/12/2020 | Alamitos Creek | O. mykiss | 18.4 | 110 | 982.126058146878 |
| 11/18/2020 | Guadalupe Creek | O. mykiss | 28.4 | 145 | 982.126058146882 |
| 10/18/2021 | Calero Creek | O. mykiss | 3.6 | 66 | 982.126059706521 |
| 10/18/2021 | Calero Creek | O. mykiss | 9.4 | 85 | 982.126059706529 |
| 10/18/2021 | Calero Creek | O. mykiss | 6.1 | 77 | 982.126059709101 |
| 10/18/2021 | Calero Creek | O. mykiss | 4.6 | 66 | 982.126059706512 |
| 10/18/2021 | Calero Creek | O. mykiss | 6.9 | 74 | 982.126059709081 |
| 10/18/2021 | Calero Creek | O. mykiss | 4.9 | 71 | 982.126059709092 |
| 10/18/2021 | Calero Creek | O. mykiss | 6.8 | 79 | 982.126059706527 |
| 10/18/2021 | Calero Creek | O. mykiss | 81.5 | 182 | 900.228000613810 |
| 10/18/2021 | Calero Creek | O. mykiss | 4.5 | 65 | 982.126059706531 |
| 10/18/2021 | Calero Creek | O. mykiss | 3.4 | 65 | 982.126059706553 |
| 10/18/2021 | Calero Creek | O. mykiss | 4.3 | 69 | 982.126059706549 |
| 10/18/2021 | Calero Creek | O. mykiss | 3.8 | 68 | 982.126059706576 |
| 10/18/2021 | Calero Creek | O. mykiss | 3.6 | 65 | 982.126059706577 |
| 10/18/2021 | Calero Creek | O. mykiss | 5.8 | 74 | 982.126059706533 |
| 10/18/2021 | Calero Creek | O. mykiss | 7.7 | 78 | 982.126059709102 |
| 10/18/2021 | Calero Creek | O. mykiss | 5.7 | 74 | 982.126059706523 |
| 10/18/2021 | Calero Creek | O. mykiss | 10.9 | 89 | 982.126059709078 |
| 10/18/2021 | Calero Creek | O. mykiss | 7.8 | 84 | 982.126059709103 |
| 10/18/2021 | Calero Creek | O. mykiss | 7.5 | 84 | 982.126059706551 |
| 10/18/2021 | Calero Creek | O. mykiss | 8.4 | 85 | 982.126059709108 |
| 10/18/2021 | Calero Creek | O. mykiss | 5.4 | 72 | 982.126059706561 |
| 10/18/2021 | Calero Creek | O. mykiss | 5.1 | 70 | 982.126059706544 |
| 10/18/2021 | Calero Creek | O. mykiss | 6.7 | 78 | 982.126059709107 |
| 10/18/2021 | Calero Creek | O. mykiss | 11.4 | 95 | 982.126059709088 |
| 10/28/2021 | Alamitos Creek | O. mykiss | 5.1 | 75 | 982.126059706552 |
| 10/29/2021 | Alamitos Creek | O. mykiss | 5 | 75 | 982.126059706554 |
| 10/29/2021 | Alamitos Creek | O. mykiss | 8.2 | 84 | 982.126059709079 |
| 11/1/2021 | Coyote Creek | O. mykiss | 117.9 | 209 | 900.228000613753 |
| 11/1/2021 | Coyote Creek | O. mykiss | 43.4 | 151 | 900.228000613754 |
| 11/1/2021 | Coyote Creek | O. mykiss | 25.2 | 126 | 982.126059706573 |
| 11/1/2021 | Coyote Creek | O. mykiss | 11.9 | 101 | 982.126059706540 |
| 11/1/2021 | Coyote Creek | O. mykiss | 13.7 | 99 | 982.126059706520 |
| 11/1/2021 | Coyote Creek | O. mykiss | 11.4 | 97 | 982.126059706563 |
| 11/1/2021 | Coyote Creek | O. mykiss | 8.9 | 86 | 982.126059709085 |
| 11/2/2021 | Coyote Creek | O. mykiss | 30.4 | 139 | 982.126059706568 |

| | | | | | |
|---|---|---|---|---|---|
| 11/2/2021 | Coyote Creek | O. mykiss | 24.2 | 129 | 982.126059709100 |
| 11/2/2021 | Coyote Creek | O. mykiss | 28.7 | 132 | 982.126059706511 |
| 11/2/2021 | Coyote Creek | O. mykiss | 17.5 | 115 | 982.126059706557 |
| 11/2/2021 | Coyote Creek | O. mykiss | 26.9 | 129 | 982.126059709087 |
| 11/2/2021 | Coyote Creek | O. mykiss | 26.7 | 124 | 982.126059706516 |
| 11/2/2021 | Coyote Creek | O. mykiss | 21.7 | 119 | 982.126059706567 |
| 11/2/2021 | Coyote Creek | O. mykiss | 9.3 | 95 | 982.126059706513 |
| 11/2/2021 | Coyote Creek | O. mykiss | 5.2 | 80 | 982.126059706555 |
| 11/2/2021 | Coyote Creek | O. mykiss | 21.1 | 119 | 982.126059706569 |
| 11/2/2021 | Coyote Creek | O. mykiss | 12.8 | 98 | 982.126059706538 |
| 11/2/2021 | Coyote Creek | O. mykiss | 16.3 | 105 | 982.126059706550 |
| 11/2/2021 | Coyote Creek | O. mykiss | 21.4 | 118 | 982.126059709095 |
| 11/2/2021 | Coyote Creek | O. mykiss | 19.8 | 110 | 982.126059706560 |
| 11/2/2021 | Coyote Creek | O. mykiss | 27.1 | 125 | 982.126059709089 |
| 11/2/2021 | Coyote Creek | O. mykiss | 18.5 | 113 | 982.126059709083 |
| 11/2/2021 | Coyote Creek | O. mykiss | 23.1 | 125 | 982.126059709096 |
| 11/3/2021 | Coyote Creek | O. mykiss | 28.4 | 131 | 982.126059706537 |
| 11/3/2021 | Coyote Creek | O. mykiss | 34.2 | 140 | 982.126059709094 |
| 11/3/2021 | Coyote Creek | O. mykiss | 14.8 | 104 | 982.126059706526 |
| 11/3/2021 | Coyote Creek | O. mykiss | 19.6 | 115 | 982.126059706566 |
| 11/3/2021 | Coyote Creek | O. mykiss | 36.9 | 147 | 982.126059709106 |
| 11/3/2021 | Coyote Creek | O. mykiss | 32.5 | 141 | 982.126059706564 |
| 11/3/2021 | Coyote Creek | O. mykiss | 17.5 | 116 | 982.126059706519 |
| 11/3/2021 | Coyote Creek | O. mykiss | 11.9 | 99 | 982.126059706562 |
| 11/3/2021 | Coyote Creek | O. mykiss | 37.8 | 148 | 982.126059706545 |
| 11/3/2021 | Coyote Creek | O. mykiss | 28.0 | 134 | 982.126059709084 |
| 11/3/2021 | Coyote Creek | O. mykiss | 15.4 | 103 | 982.126059706572 |
| 11/3/2021 | Coyote Creek | O. mykiss | 17.3 | 112 | 982.126059709098 |
| 11/3/2021 | Coyote Creek | O. mykiss | 28.4 | 132 | 982.126059709093 |
| 11/3/2021 | Coyote Creek | O. mykiss | 29.5 | 135 | 982.126059706547 |
| 11/3/2021 | Coyote Creek | O. mykiss | 43.7 | 150 | 900.228000613813 |
| 11/3/2021 | Coyote Creek | O. mykiss | 23.6 | 126 | 982.126059709086 |
| 11/3/2021 | Coyote Creek | O. mykiss | 21.2 | 117 | 982.126059706528 |
| 11/3/2021 | Coyote Creek | O. mykiss | 689 | 380 | 900.228000613812 |
| 11/3/2021 | Coyote Creek | O. mykiss | 19.9 | 114 | 982.126059706515 |
| 11/3/2021 | Coyote Creek | O. mykiss | - | 151 | 900.228000613814 |
| 11/3/2021 | Coyote Creek | O. mykiss | 418 | 320 | 900.228000613816 |
| 11/3/2021 | Coyote Creek | O. mykiss | 26.7 | 127 | 982.126059706534 |
| 11/3/2021 | Coyote Creek | O. mykiss | 132.3 | 252 | 900.228000613815 |
| 11/3/2021 | Coyote Creek | O. mykiss | 14.0 | 104 | 982.126059706574 |
| 11/4/2021 | Guadalupe Creek | O. mykiss | 18.8 | 120 | 982.126059706522 |
| 11/4/2021 | Guadalupe Creek | O. mykiss | 5.8 | 78 | 982.126059706524 |
| 11/4/2021 | Guadalupe Creek | O. mykiss | 7.6 | 81 | 982.126059709109 |
| 11/4/2021 | Guadalupe Creek | O. mykiss | 6.1 | 81 | 982.126058146865 |
| 11/4/2021 | Guadalupe Creek | O. mykiss | 22.6 | 126 | 982.126058146880 |
| 11/4/2021 | Guadalupe Creek | O. mykiss | 52.8 | 171 | 900.228000613899 |
| 11/8/2021 | Stevens Creek | O. mykiss | 95.1 | 198 | 900.228000613898 |
| 11/8/2021 | Stevens Creek | O. mykiss | 11.6 | 95 | 982.126058146835 |

| | | | | | |
|---|---|---|---|---|---|
| 11/8/2021 | Stevens Creek | O. mykiss | 114 | 207 | 982.126058146870 |
| 11/8/2021 | Stevens Creek | O. mykiss | 11.2 | 96 | 982.126058146885 |

# Coyote Creek 2020-2021 Adult Salmonid Migration Monitoring Using the Vaki Riverwatcher Passive Monitoring System at the Coyote Percolation Dam Fish Ladder

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July 2021

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# Appendices

Appendix A: Spawning Survey Memos

Appendix B: Example Silhouettes and Video Images

## Introduction

Steelhead (*Oncorhynchus mykiss, O. mykiss* for the remainder of the document) in the Central California Coast (CCC) Distinct Population Segment (DPS) were listed as threatened by the National Marine Fisheries Service (NMFS) in 1997. Due to their protected status, Valley Water (formerly the Santa Clara Valley Water District) implemented a noninvasive means of documenting adult steelhead escapement in Coyote Creek using the Vaki Riverwatcher (Vaki) System. The Vaki is a computer-based fish counter that employs scanner plates and a digital camera to capture videos and silhouette images of fish as they pass between the plates. The Vaki provides information on the occurrence and timing of adult fish migration both upstream and downstream through the counter. This monitoring also allows for detections of other anadromous fish such as Chinook salmon (*Oncorhynchus tshawytscha*) and Pacific lamprey (*Entosphenus tridentatus*).

The Coyote Creek Vaki unit was installed within the fish ladder at the Coyote Percolation Facility during the migration season (October to May) (Figure 1). The fish ladder was constructed in 1999 to enable fish passage around the Coyote Diversion Dam, which had previously created an impassable barrier to fish migration. The first Coyote Creek Vaki monitoring period was the 2018-2019 migration season. Monitoring occurred the following season from October 2019-May 2020. In October 2020, the Vaki began operation for a third monitoring period and is the focus of this report.

## Installation, Operation, and Maintenance

The Coyote Percolation Facility fish ladder is located 51 kilometers upstream of the South San Francisco Bay on Coyote Creek and immediately downstream of Metcalf Pond between Metcalf Road and Highway 101 (Figure 1). The Vaki was installed in the fish ladder and began operating on October 1, 2020 (Figure 2). The counter itself is a rectangular-shaped unit outfitted with scanner plates, a camera, and infrared light-emitting diodes on the interior (Figure 3) and is completely submerged underwater

within the fish ladder. Adult fish are directed through the counter opening by use of weirs in the ladder. When a fish swims through the counter and breaks the plane of light beams, the fish is scanned and a resulting silhouette image is sent to the onsite computer. Other information recorded during each detection includes the speed the fish was traveling, the direction the fish was moving (upstream or downstream), body depth (for estimating length based on length-to-depth ratios from the literature), along with the date and time of the detection. A detection also triggers a digital camera that records a 12.4-second video for fish traveling upstream and a 12.4-second video for fish traveling downstream. The minimum depth size to trigger a Vaki detection was changed from 40mm to 50mm on December 7, 2020 to minimize the detections of bubbles. A 50 mm body depth still allows for *O. mykiss* over 350 mm to be recorded. The videos are used to confirm the presence of a fish and improve confidence in species identification.

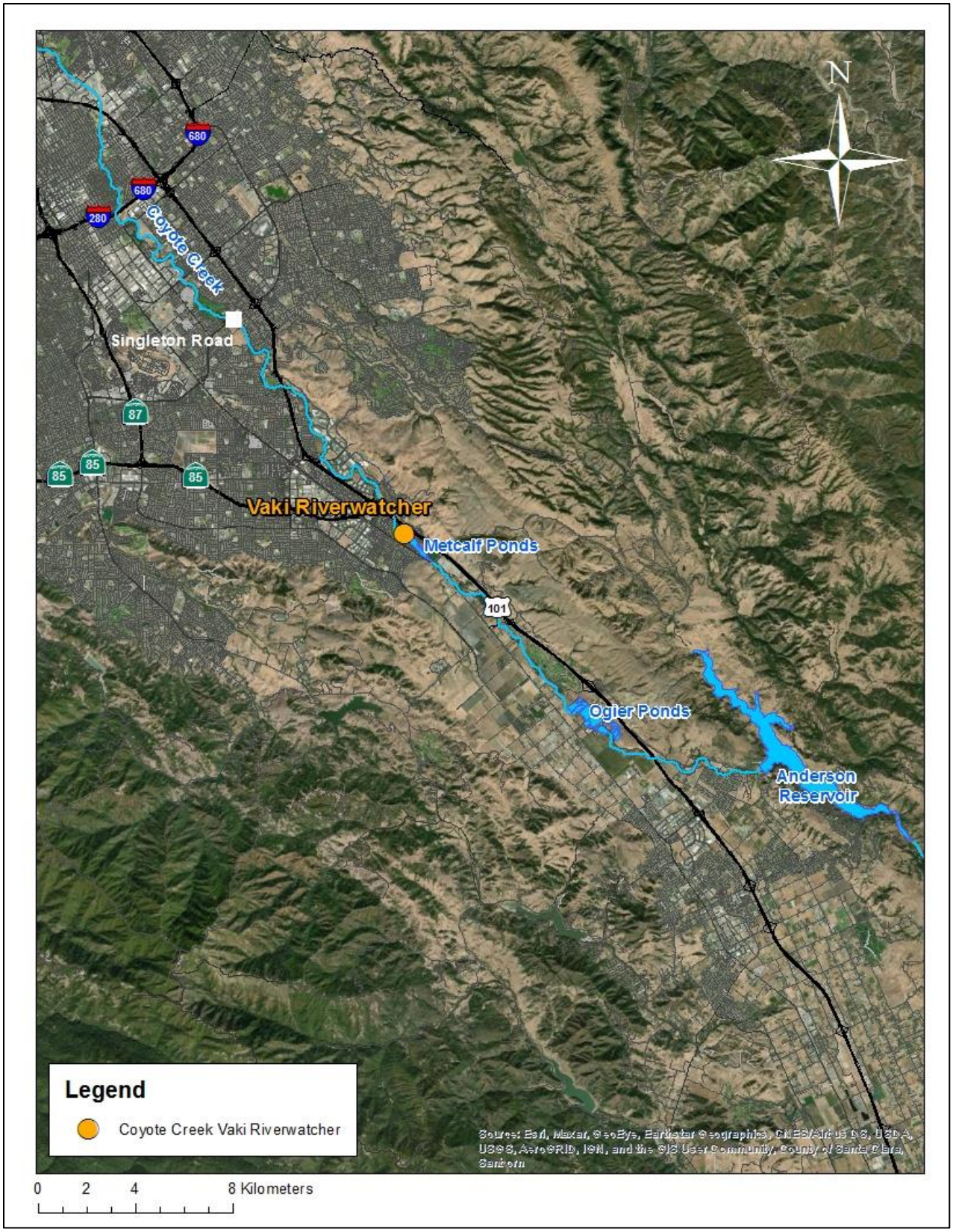


Figure 1. Coyote Creek Vaki Riverwatcher location.

Figure 2. Installation of the Vaki Riverwatcher system in the Coyote Creek Fishway. The black box indicates the fish counter.

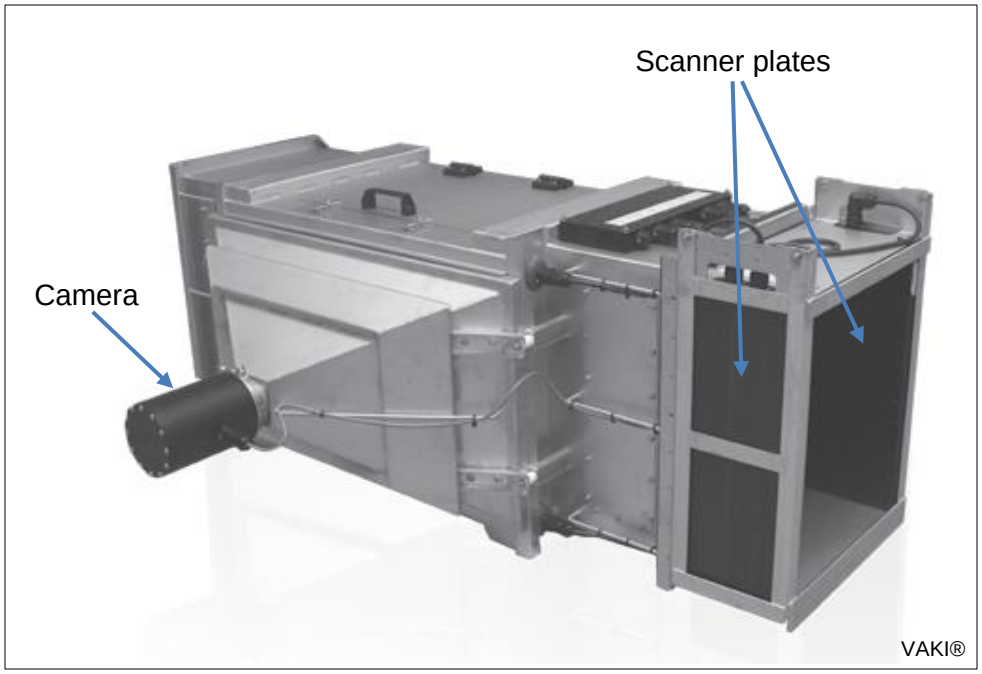


Figure 3. Vaki Riverwatcher fish counter.

All the data collected by the Vaki were stored on the attached onsite computer. Data was manually downloaded from the computer up to once a week and transferred to the Valley Water network. Once the data was downloaded, the onsite computer database was reset. The files were vetted by Valley Water staff as soon as possible following the download. During the weekly visits to download data, Valley Water staff also performed maintenance by cleaning debris and algal build-up on the scanner plates and plexiglass in front of the camera with a Mr. Long Arm® brush.

The Vaki was attached directly to the AC power grid operated by Pacific Gas and Electric (PG&E). After any power outages, the onsite computer was unable to automatically reopen the Vaki software causing gaps in the data until the Vaki was visited and the program was manually reopened. A power outage occurred between October 3, 2020 and the first maintenance visit on October 5, 2020 resulting in approximately two days of lost footage. A second outage occurred on March 5 and was discovered when the Vaki was checked on March 8, 2021, approximately three days of lost footage. The Vaki lost power for a third time from April 13, 2021 to April 19, 2021,

approximately 6 days of lost footage. The power cable was found disconnected during the Vaki maintenance check on April 19. A total of approximately eleven days of fish monitoring were missed due to Vaki outages. It is possible that migrating fish passed through the Vaki during these periods of non-operation. Spawning surveys were implemented within one week of staff discovering that the Vaki had lost power during the steelhead migration season (Appendix A). Spawning surveys occurred on March 11 and 12 and April 22 following the outages on in March and April, respectively.

Table 1. 2020-2021 Vaki outage durations and causes.

| Duration of outage (hours) | Cause of outage | Start of outage | End of outage |
|---|---|---|---|
| 52 | Power outage | 10/03/2020 08:22 | 10/5/2020 12:00 |
| 78 | Power Outage | 3/5/2021 07:04 | 3/8/2021 13:06 |
| 142 | Cable disconnected | 4/13/2021 11:42 | 4/19/2021 09:32 |
| **Total duration of outage: 272 hours (approx. 11 days)** | | | |

Due to the COVID-19 pandemic that began in March 2020, Vaki maintenance was scheduled for once a week to minimize the amount of exposure with coworkers and the public. Masks were worn and social distancing guidelines were adhered to during visits.

The Vaki was powered off for the season on June 1, 2021.

## Data Analysis

The Vaki recorded silhouettes and videos of all items large enough to break the plane of the diodes (body depth of 50 mm or greater). Scanned infrared silhouettes and video images were reviewed using the Winari software to ensure that only fish passage events were included in the overall passage counts. Videos were used to identify fish to species when conditions provided clear images, and silhouettes were also used to identify fish to species if identifying characteristics were present. Detections without accompanying videos were only sorted into specific species categories if the silhouette

was clear and the confidence level of identification was high; otherwise, these detections were sorted into the “unknown fish” category. Videos with two or more species present were placed into the “multiple species” category, unless one of the species detected was an anadromous fish. A confidence level rating system analyzing both silhouette and video quality was used to rate the likelihood of accurate identification for anadromous fish (Table 2). This rating system was used for Chinook salmon as this was the only anadromous species detected by the Vaki during the 2020-2021 monitoring period.

Table 2. Confidence rating system used for identifying Vaki detections of anadromous fish species.

| | **High quality video** | **Average quality video** | **Poor quality video** | **Video absent** |
|---|---|---|---|---|
| **High quality silhouette** | High confidence | High confidence | Medium confidence | Medium confidence |
| **Average quality silhouette** | High confidence | High confidence | Medium confidence | Low confidence |
| **Poor quality silhouette** | High confidence | Medium confidence | Low confidence | Can’t be categorized |
| **Silhouette absent** | High confidence | Medium confidence | Low confidence | N/A |

Length-to-depth ratios were used to estimate the lengths of specific individuals based upon their body depth as measured by the Vaki. The length-to-depth ratios for *O. mykiss* were 4.1:1 for small fish and 4.8:1 for medium and large fish (Cuthbert et al. 2013). The length-to-depth ratios used for Chinook salmon was 4.2:1 for small, medium, and large fish.

*O. mykiss* with a standard length greater than 350 mm were classified as adult *O. mykiss*, while anything 350 mm and below were determined to be juveniles (Moyle, 2002). The scanner plates trigger a detection and a video recording only when the body depth range specified is detected. This results in a lack of detection for *O. mykiss* with an estimated fork length of 159 mm or less.

Since one fish may move upstream and downstream through the fish counter multiple times in a given time span, body depths along with proximity in timing were used to differentiate detections of Chinook salmon at the individual level in order to obtain a more accurate count of the total number of Chinook salmon passing through the counter.

The Vaki system is designed to track adult migratory fish with a clear migratory path (i.e., anadromous fish), but it does not provide the ability to estimate the number of fish using the habitat in which the system is installed. For Centrarchidae, Cyprinidae, Ictaluridae, and Catostomidae species that are not migrating, detection indicates presence but cannot be used to assess population numbers. These species were amalgamated by family for analysis and reporting purposes, but the species name was noted if positive identification was possible.

## Results

A total of 15,830 videos were recorded during the 2020-2021 monitoring season. Of these, 2,560 were identified as fish detections. Non-anadromous fish in the Catostomidae, Centrarchidae, Cyprinidae, and Ictaluridae families accounted for 1,427 of the detections, and 1,086 detections were placed in the unknown fish category. There were thirteen videos with multiple species of non-anadromous fish present.

The Centrarchidae species positively identified included largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*). Hitch (*Lavinia exilicauda*), common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*) were the Cyprinidae species that were positively identified. The Catostomidae species positively identified was the Sacramento sucker (*Catostomos occidentalis*) and the only Ictaluridae species positively identified by the Vaki included channel catfish (*Ictalurus punctatus*). Examples of positive species identifications can be seen in Appendix B.

No *O. mykiss* or Pacific lamprey were identified during the 2020-2021 monitoring season. Of the 1,086 unknown fish detections, only 161 were greater than 350 mm in

length, which is the estimated minimum size for adult *O. mykiss*. Of these 161 detections, 86 were recorded during the *O. mykiss* migration window of December to April with only 12 detections in the upstream direction.

Chinook salmon was the only anadromous fish species identified during the 2020-2021 monitoring season with a total of 34 detections. Detections of Chinook salmon were run through the confidence matrix (Table 2), and the rating of those detections can be seen in Table 3.

Table 3: Confidence rating system for Chinook salmon detections based on Table 2.

| **Confidence Rating** | **High** | **Medium** | **Low** |
|---|---|---|---|
| Chinook Salmon | 18 | 15 | 1 |

Of the thirty-four Chinook salmon detections, twenty-three were recorded moving upstream and eleven were recorded moving downstream. Based on body depth comparisons and proximity in timing, it was determined that up to twenty individual Chinook salmon passed through the Vaki. The size range of Chinook salmon detected ranged from 220 mm to 690 mm. Some detections occurred on the same day and were in both the upstream and downstream direction. The timing of the Chinook salmon detections and the Vaki outages can be seen in Figure 4.

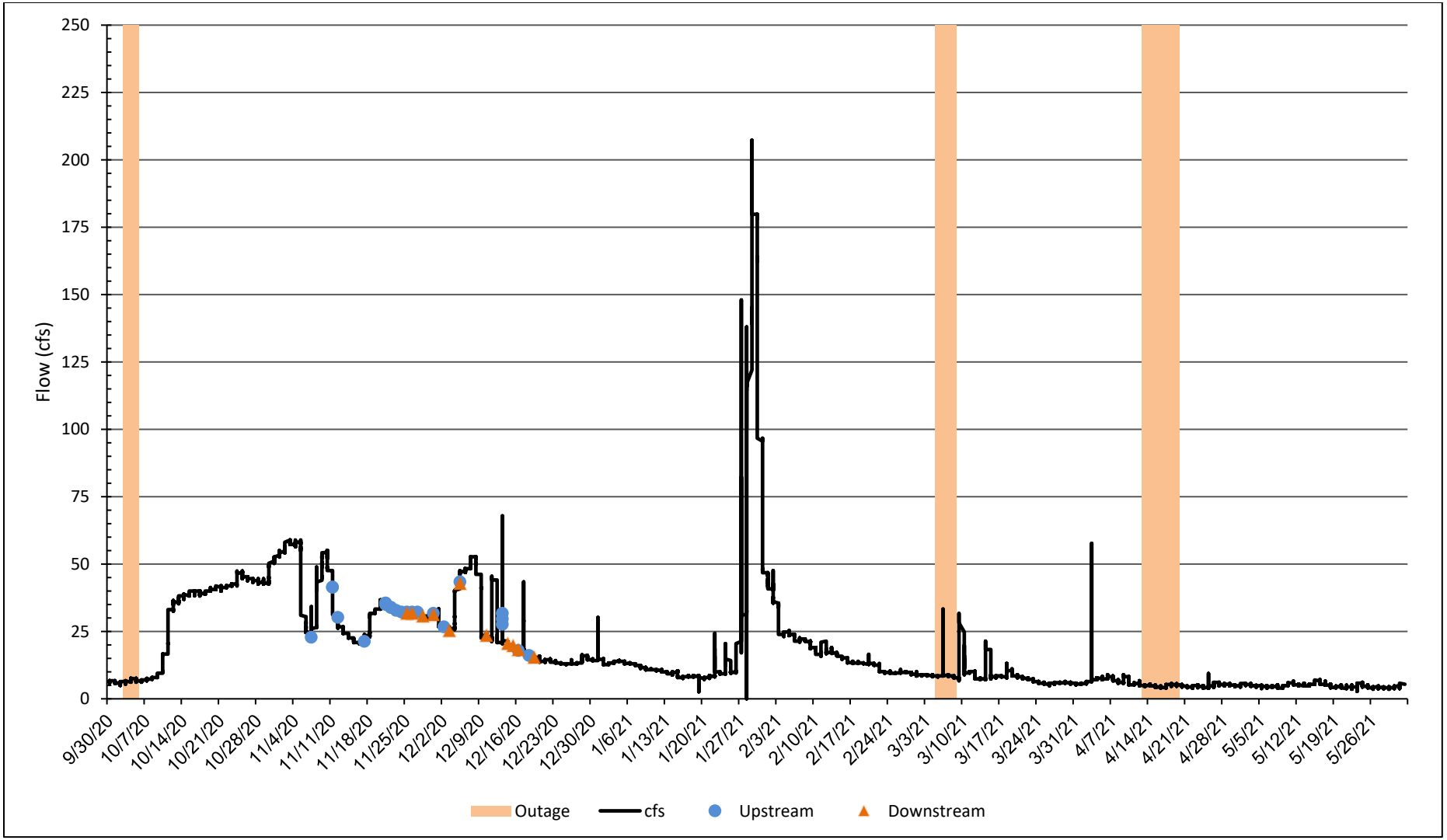


Figure 4. Vaki outages and Chinook salmon detections in relation to stream flow (cubic feet per second) on Coyote Creek at Stream Gage ALERT 5058 at Edenvale.

## Discussion

Per Moyle et al. (2008), adult *O. mykiss* typically begin their upstream migration between December and April. Peak flows during the 2020-2021 monitoring season occurred during late January, reaching approximately 200 cfs. The Vaki was operational during this flow event and did not detect *O. mykiss*. The Vaki experienced three outages during the monitoring season, two of which occurred during the *O. mykiss* migration period (3/05/21-3/08/21 and 4/13/21-4/19/21) and one which occurred during the Chinook salmon migration period (10/03/20-10/05/20). It is possible that individuals went undetected during the outages. To account for any adult *O. mykiss* escapement, spawning surveys were implemented within one week of the discovery of each outage during the *O. mykiss* migration season. No live adults, redds or carcasses were found during these surveys, thus limiting the likelihood of *O. mykiss* passing through the Vaki during outages. Finally, there is the potential that *O. mykiss* and Chinook salmon were detected swimming through the Vaki but could not be identified and were placed in the unknown fish category due to poor video or silhouette quality. As mentioned in the results section of this document, only a small number of the unknown fish detections were of adult *O. mykiss* size and moving in the upstream direction.

Based on the timing of the Chinook salmon detections and the multiple hits in both directions on a given day, it is likely that the number of individual Chinook salmon moving through the Vaki was less than the number of detections. Based on body depth comparisons and proximity in timing, it was determined that up to twenty individual Chinook salmon passed through the Vaki. There was an outage during the Chinook salmon migration season that could have resulted in missed individuals; however, this outage occurred during a period of relatively low flow, which would have likely limited adult upstream migration.

Of the thirty-four Chinook salmon detections at the Vaki, seventeen were determined to have an intact adipose fin using videos and silhouette images. Nine detections did not have an adipose fin and eight detections could not be determined. The presence of adipose fin clipped fish confirms that the run is supplemented by hatchery strays, and

the percentage of adipose fin clipped fish is consistent with the fractional marking system (25%) used in the hatchery system.

The Vaki Riverwatcher is not designed to track the movement of juvenile *O. mykiss*, which may have gone unidentified during the monitoring season. The small size of the juvenile fish allows them to potentially swim through the weir bars outside of the Vaki or swim through the scanner plates without triggering the diodes, thus avoiding detection.

The 2020-2021 monitoring season overall had limited precipitation and limited stream flow, reducing opportunity for upstream passage of *O. mykiss*. The drawdown of Anderson Reservoir under the Federal Energy Regulatory Commission order created increase flows during the Chinook salmon migration period. These flows provided migration and spawning conditions suitable for Chinook salmon.

## References

Anderson, J.T., Merz, J.E., Watry, C.B., Saiki, M.K. (2015). Comparison of selected population characteristics of adult chinook salmon during upstream passage through a resistance board weir and during carcass surveys. California Fish and Game. 101(1):24-39.

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Moyle, P. B., Israel, J. A., Purdy, S. E. (2008). Salmon, Steelhead, and Trout in California: Status of Emblematic Fauna. Center for Watershed Sciences, University of California Davis.

# Appendix A

# Spawning Survey Memos

**Spawning Surveys – March 2021**

## Introduction

On February 20, 2020 the Federal Energy Regulatory Commission (FERC) ordered Santa Clara Valley Water District (Valley Water) to begin draining Anderson Reservoir to deadpool, 488 ft. elevation, as quickly and safely as possible no later than October 1, 2020. Lowering the reservoir elevation to this level was anticipated to have consequences for downstream natural resources including federally threatened Central California Coast Steelhead (*Oncorhynchus mykiss*), which occur downstream of Anderson Dam and rely on cold water releases from the reservoir.

On July 24, 2020, Valley Water filed a Final Reservoir Operations and Drawdown Plan to describe the implementation of the February 20, 2020 FERC Order with avoidance and minimization measures. In response, FERC issued an order on October 1, 2020 regarding portions of the Reservoir Operations and Drawdown Plan. Ordering Paragraph B(10) required Valley Water to develop a Fisheries Monitoring Adaptive Management Plan that defined the goals, and methods to achieve those goals, for monitoring fisheries and habitat. Valley Water developed the Water Temperature and Fisheries Monitoring Plan (Valley Water, 2020) (Plan) to comply with the October 1, 2020 Order, finalized in December 2020. Section 4 of the Plan details several monitoring efforts to determine the presence of *O. mykiss* within Critical Habitat and specifically within the Cold Water Management Zone (CWMZ) of Coyote Creek.

Section 4.2 of the Plan outlines the operation of the Vaki Riverwatcher (Vaki), a computer-based fish counter used to estimate adult escapement into the CWMZ of Coyote Creek. The Vaki records silhouettes and videos of fish passing through the counter. Per Section 4.3 of the Plan (Spawning Surveys), if a power outage at the Vaki occurs, footage cannot be reviewed within a week, or if conditions reduce data quality, spawning surveys will be implemented within one week of identifying the issue.

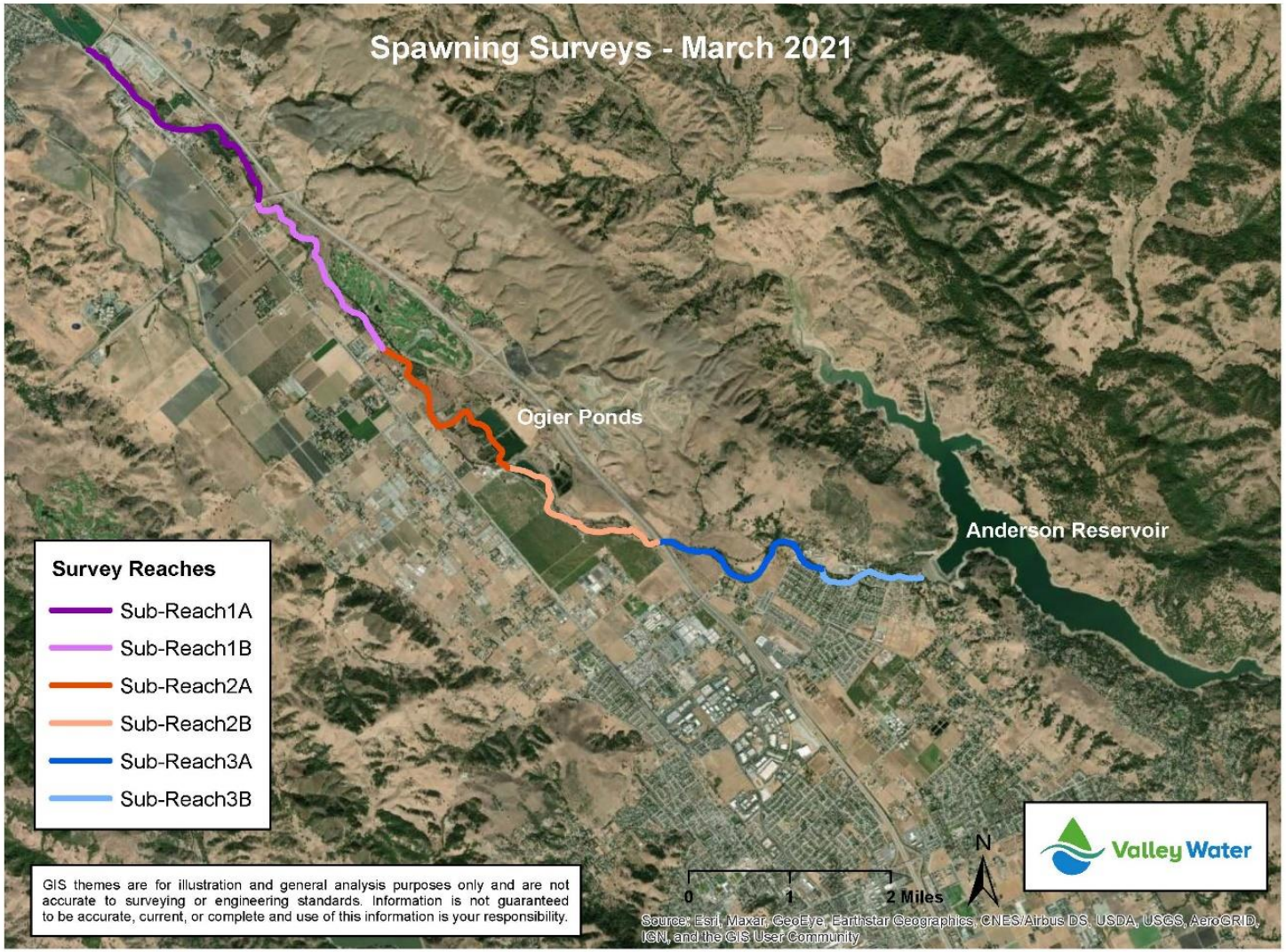
On March 5, 2021, the Vaki experienced a power outage that triggered Valley Water to conduct spawning surveys.

## Methods

Spawning surveys were conducted on March 11 and 12, six days after the outage at the Vaki occurred. Spawning surveys were conducted according to methods outlined in Section 4.3 of the Plan (Valley Water, 2020). Spawning surveys covered the portion of Coyote Creek between Metcalf Road and Anderson Dam, approximately 9 miles. The area was divided into three reaches using major landmarks as reach start and endpoints, and each reach was divided into two sub-reaches (Figure 1):

- Reach 1: Metcalf Road to Coyote Creek Golf Drive
    - Sub-reach 1A: Metcalf Road to Bailey Avenue
    - Sub-reach 1B: Bailey Avenue to Coyote Creek Golf Drive
- Reach 2: Coyote Creek Golf Drive to Highway 101
    - Sub-reach 2A: Coyote Creek Golf Drive to Barnhart Avenue
    - Sub-reach 2B: Barnhart Avenue to Highway 101
- Reach 3: Highway 101 to Anderson Dam

- Sub-reach 3A: Highway 101 to Sycamore Avenue (Boys Ranch)
- Sub-reach 3B: Sycamore Avenue to Anderson Dam




Document Name: SpawningSurveyReaches

Figure 1. Spawning Survey sub-reaches on Coyote Creek. Spawning surveys started at Metcalf Road and sub-reaches were sampled consecutively to the base on Anderson Dam.

Spawning surveys were conducted on foot by two to three Valley Water biologists with experience and training in redd identification. Starting at the most downstream reach, biologists visually surveyed suitable spawning habitat for steelhead redds and the presence of adult fish. Water temperature, estimated flow, turbidity, visibility, and survey start and end time were recorded for each sub-reach (Table 1).

Table 1. Stream metrics collected for each sub-reach.

| Date | Sub-Reach | Start Time | End Time | Water Temp (°C) | Estimated Flow (cfs) | Turbidity (NTU) | Visibility (m) |
|---|---|---|---|---|---|---|---|
| 3/11/2021 | 1A | 08:33 | 09:34 | 13.06 | 10 | 24.6 | 1.0 |
| 3/11/2021 | 1B | 09:50 | 11:39 | 12.95 | 15 | 33.0 | 0.7 |
| 3/11/2021 | 2A | 12:24 | 13:40 | 14.03 | 15 | 31.1 | 0.5 |
| 3/12/2021 | 2B | 08:37 | 10:00 | 10.80 | 30 | 16.7 | 1.0 |
| 3/12/2021 | 3A | 10:50 | 12:15 | 11.80 | 35 | 11.7 | 1.0 |
| 3/12/2021 | 3B | 13:00 | 13:40 | 13.21 | 35 | 13.3 | 1.0 |

**Results**

Stream flow conditions and visibility allowed for two consecutive days of spawning surveys. Turbidity readings allowed surveyors to assess the substrate for the majority of reaches within the survey area. Deep pools were skipped due to unsuitable spawning substrate and for safety concerns.

No redds, live adult fish, or salmonid carcasses were observed during the spawning surveys. Two *O. mykiss* were potentially observed in Reach 3A; however, a definitive species ID could not be determined before fish entered cover. The two potential *O. mykiss* were not the size of adult steelhead and were not observed in a section of stream with suitable spawning substrate, nor were they displaying spawning behavior.

**References**

Valley Water. 2020. FOCP Water Temp and Fisheries Monitoring Plan. Prepared by Valley Water. San Jose, CA

# Spawning Surveys – April 2021

**Introduction**

On February 20, 2020 the Federal Energy Regulatory Commission (FERC) ordered Santa Clara Valley Water District (Valley Water) to begin draining Anderson Reservoir to deadpool, 488 ft. elevation, as quickly and safely as possible no later than October 1, 2020. Lowering the reservoir elevation to this level was anticipated to have consequences for downstream natural resources including federally threatened Central California Coast Steelhead (*Oncorhynchus mykiss*), which occur downstream of Anderson Dam and rely on cold water releases from the reservoir.

On July 24, 2020, Valley Water filed a Final Reservoir Operations and Drawdown Plan to describe the implementation of the February 20, 2020 FERC Order with avoidance and minimization measures. In response, FERC issued an order on October 1, 2020 regarding portions of the Reservoir Operations and Drawdown Plan. Ordering Paragraph B(10) required Valley Water to develop a Fisheries Monitoring Adaptive Management Plan that defined the goals, and methods to achieve those goals, for monitoring fisheries and habitat. Valley Water developed the Water Temperature and Fisheries Monitoring Plan (Valley Water, 2020) (Plan) to comply with the October 1, 2020 Order, finalized in December 2020. Section 4 of the Plan details several monitoring efforts to determine the presence of *O. mykiss* within Critical Habitat and specifically within the Cold Water Management Zone (CWMZ) of Coyote Creek.

Section 4.2 of the Plan outlines the operation of the Vaki Riverwatcher (Vaki), a computer-based fish counter used to estimate adult escapement into the CWMZ of Coyote Creek. The Vaki records silhouettes and videos of fish passing through the counter. Per Section 4.3 of the Plan (Spawning Surveys), if a power outage at the Vaki occurs, footage cannot be reviewed within a week, or if conditions reduce data quality, spawning surveys will be implemented within one week of identifying the issue.

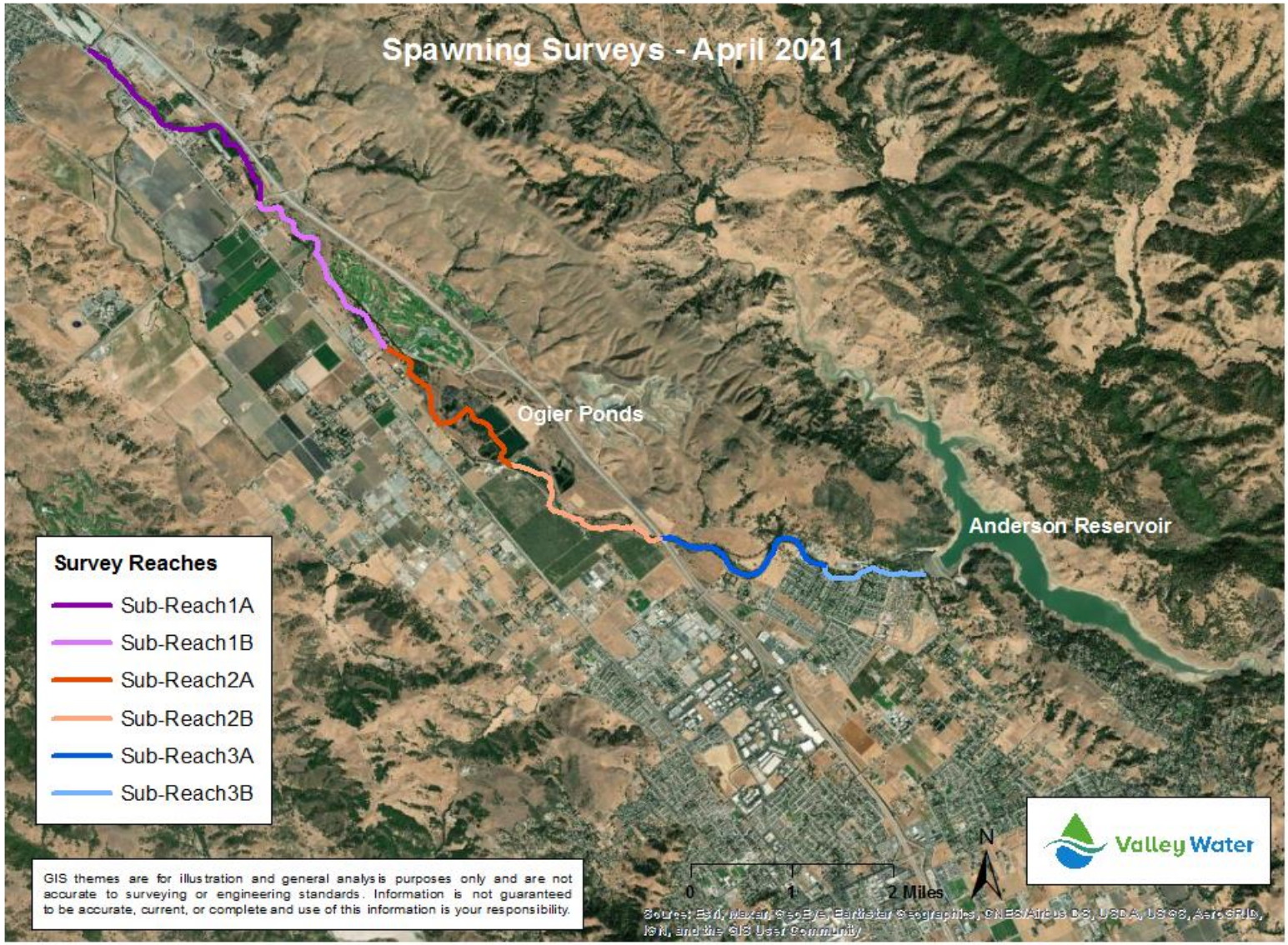
On April 19, 2021, the Vaki experienced a power outage that triggered Valley Water to conduct spawning surveys.

# Methods

A spawning survey was conducted on April 22, three days after the outage at the Vaki occurred. The spawning survey was conducted according to methods outlined in Section 4.3 of the Plan (Valley Water, 2020). Spawning surveys covered the portion of Coyote Creek between Metcalf Road and Anderson Dam, approximately 9 miles. The area was divided into three reaches using major landmarks as reach start and endpoints, and each reach was divided into two sub-reaches (Figure 1):

- Reach 1: Metcalf Road to Coyote Creek Golf Drive
    - Sub-reach 1A: Metcalf Road to Bailey Avenue
    - Sub-reach 1B: Bailey Avenue to Coyote Creek Golf Drive
- Reach 2: Coyote Creek Golf Drive to Highway 101
    - Sub-reach 2A: Coyote Creek Golf Drive to Barnhart Avenue
    - Sub-reach 2B: Barnhart Avenue to Highway 101
- Reach 3: Highway 101 to Anderson Dam

- Sub-reach 3A: Highway 101 to Sycamore Avenue (Boys Ranch)
- Sub-reach 3B: Sycamore Avenue to Anderson Dam




Document Name: SpawningSurveyReaches

Figure 1. Spawning Survey sub-reaches on Coyote Creek. Spawning surveys started at Metcalf Road and sub-reaches were sampled consecutively to the base on Anderson Dam.

The spawning survey was conducted on foot by two Valley Water biologists with experience and training in redd identification. Starting at the most downstream reach, biologists visually surveyed suitable spawning habitat for steelhead redds and the presence of adult fish and carcasses. Water temperature, estimated flow, turbidity, visibility, and survey start and end time were recorded for each reach (Table 1).

Table 1. Stream metrics collected for each sub-reach.

| Date | Reach | Start Time | End Time | Water Temp (°C) | Estimated Flow (cfs) | Turbidity (NTU) | Visibility (m) |
|---|---|---|---|---|---|---|---|
| 4/22/21 | 1 | 09:08 | 11:08 | 16.51 | *14 | 21.1 | 1 |
| 4/22/21 | 2 | 11:08 | 13:10 | 16.28 | - | 21.3 | 0.7 |
| 4/22/21 | 3 | 13:15 | 14:48 | 14.84 | *44 | 77.7 | 1.1 |

*Stream Gauges 5007 and 5082 used for estimated flow.

# Results

Stream flow conditions and visibility allowed biologists to complete the spawning survey in one day. Turbidity readings allowed surveyors to assess the substrate for the majority of reaches within the survey area. Deep pools were skipped due to unsuitable spawning substrate and for safety concerns.

No redds, live adult fish, or salmonid carcasses were observed during the spawning surveys. Although other species, such as carp and Sacramento suckers were observed.

# References

Valley Water. 2020. FOCP Water Temp and Fisheries Monitoring Plan. Prepared by Valley Water. San Jose, CA

# Appendix B

# Example Silhouettes and Video Images

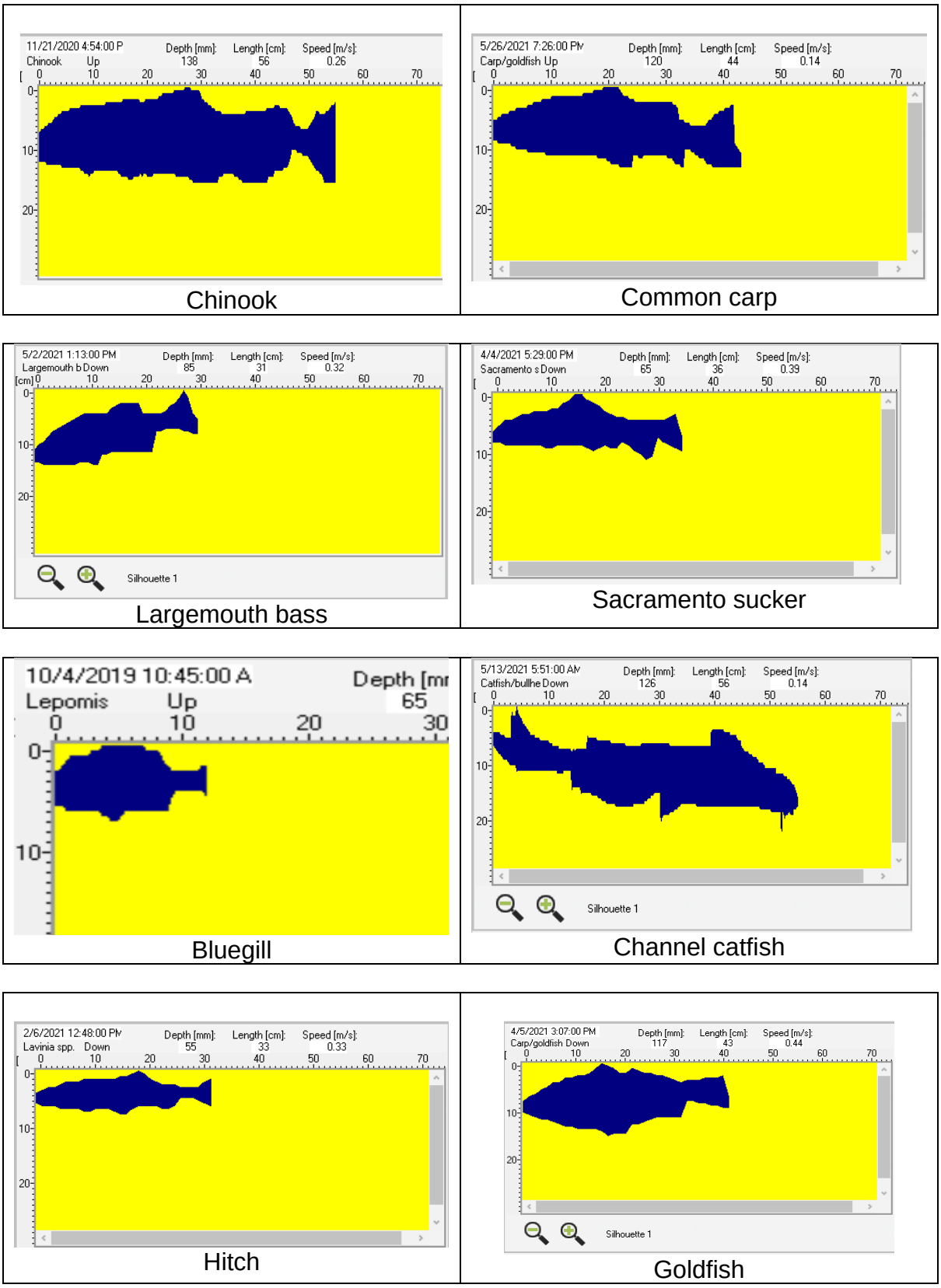



Figure B-1. Examples of silhouette images generated by the Vaki for each fish species referenced in the report.

Figure B-2. Vaki video image of Chinook Salmon (*Oncorhynchus tshawytscha*) .

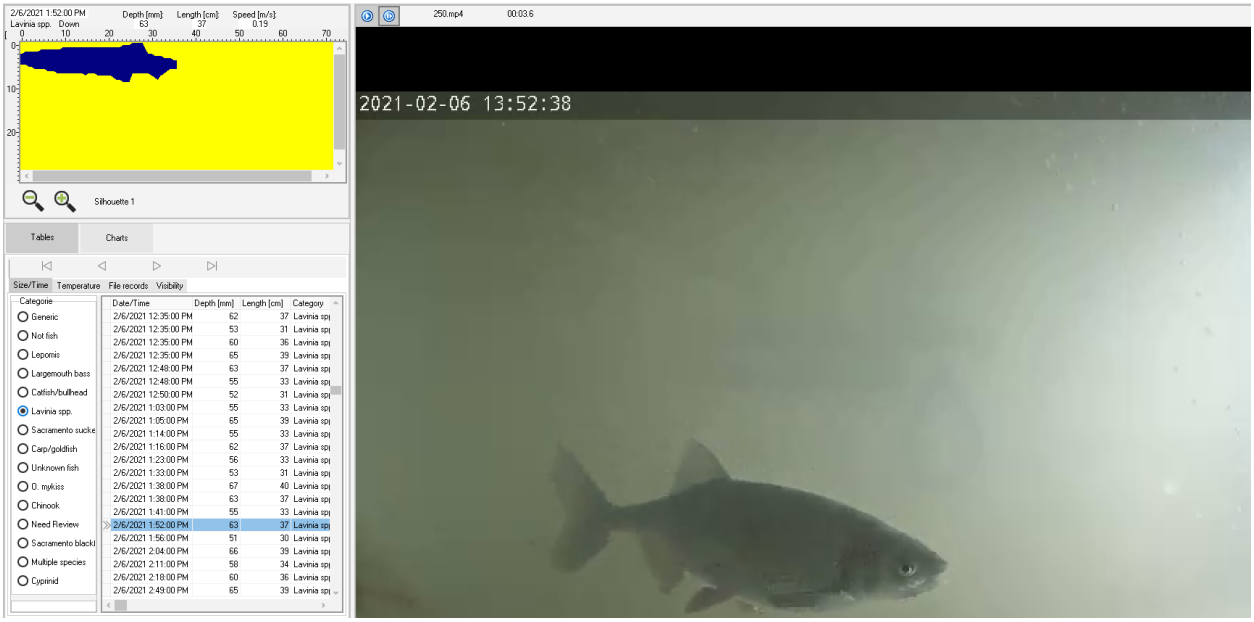



Figure B-3. Vaki video image of a Hitch (*Lavinia exilicauda*; classified as *Lavinia spp.*).

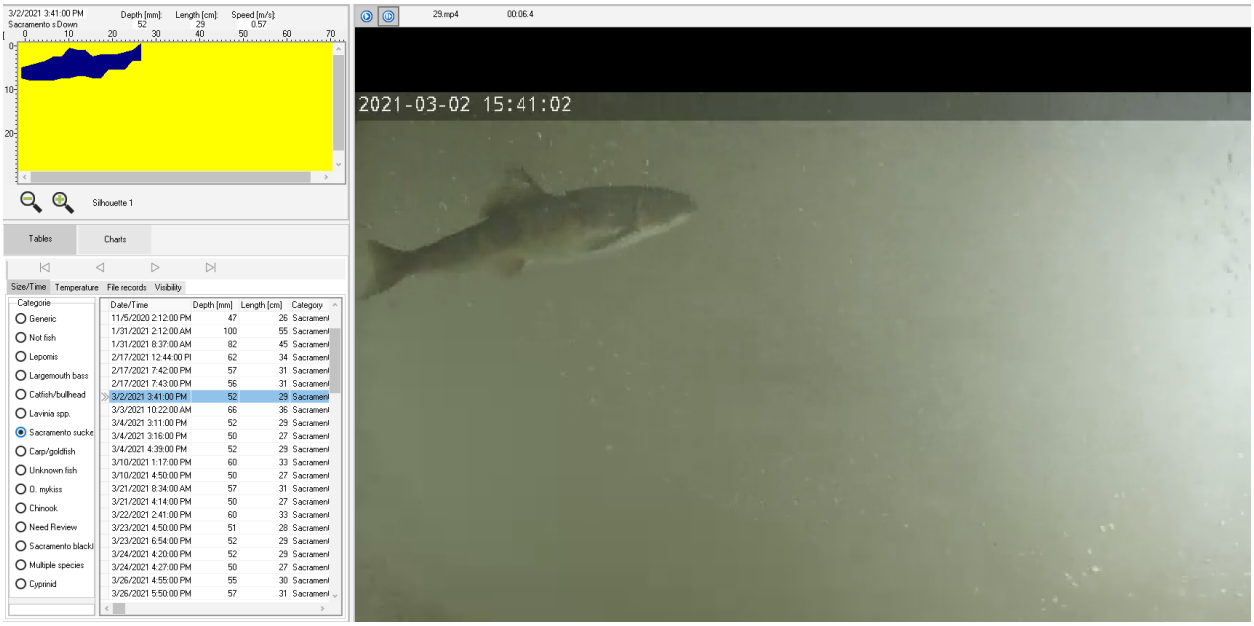



*Figure B-4. Vaki video image of a Sacramento sucker (*Catostomus occidentalis*).*

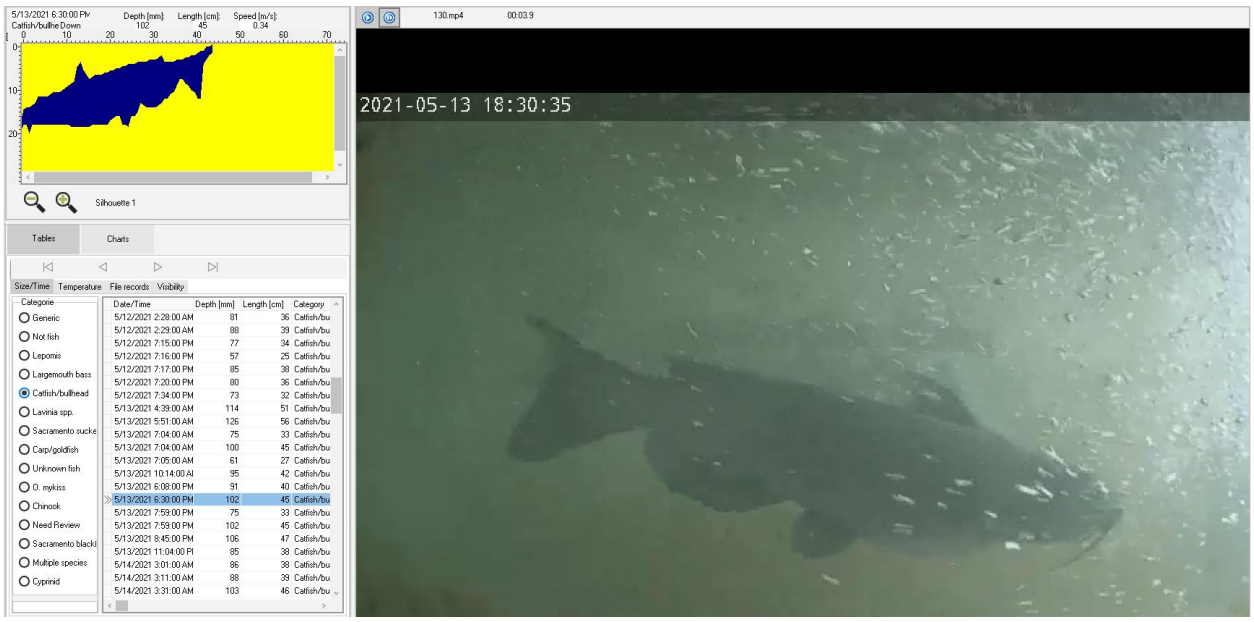



Figure B-5. Vaki video image of a Channel catfish (*Ictalurus punctatus*).

Figure B-6. Vaki video image of a Common carp (*Cyprinus carpio*).

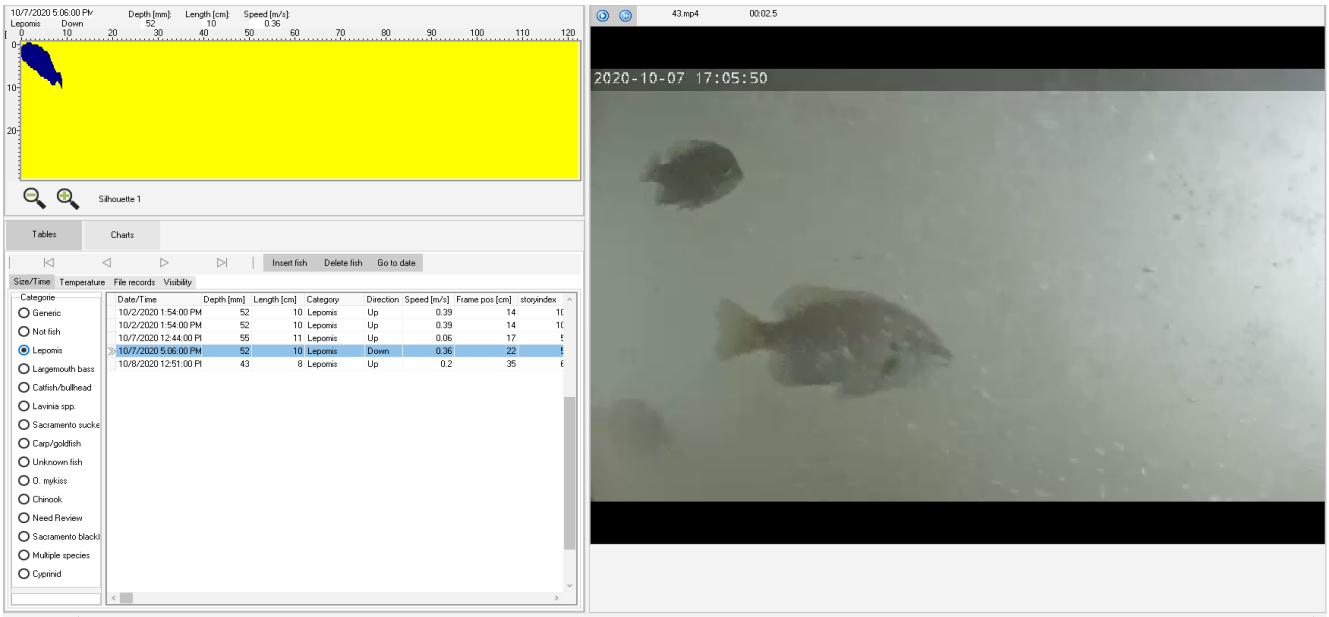



Figure B-7. Vaki video image of a Bluegill (*Lepomis macrochirus*; classified as *Lepomis spp*).

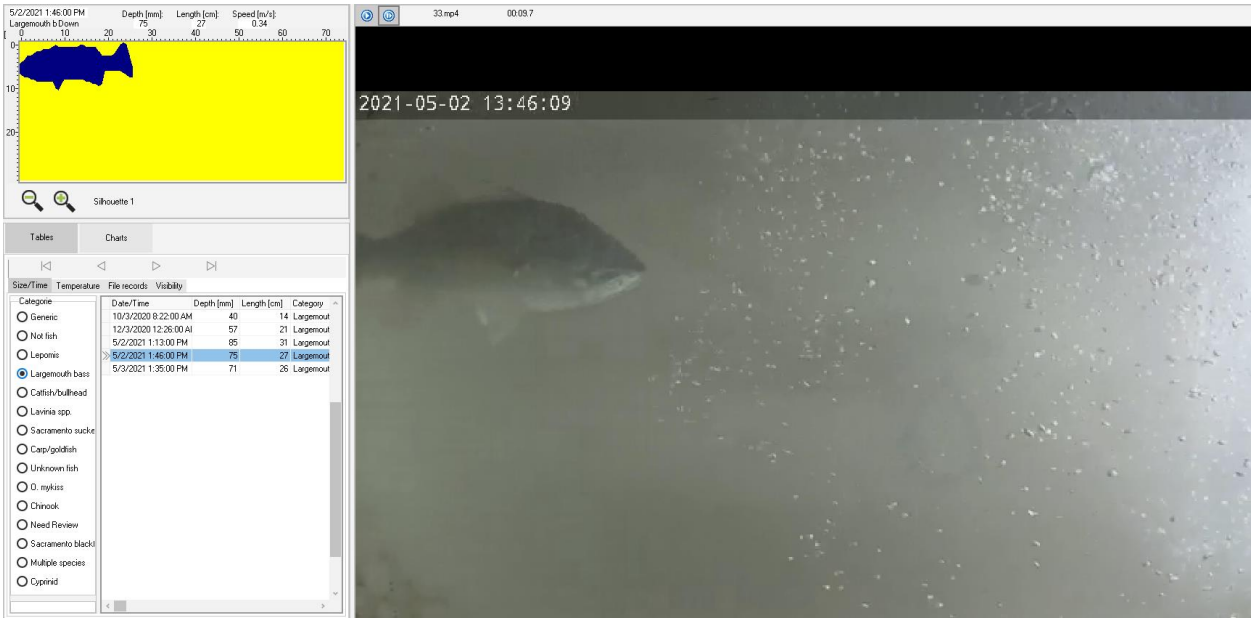



Figure B-8. Vaki video image of a Largemouth bass (*Micropterus salmoides*).

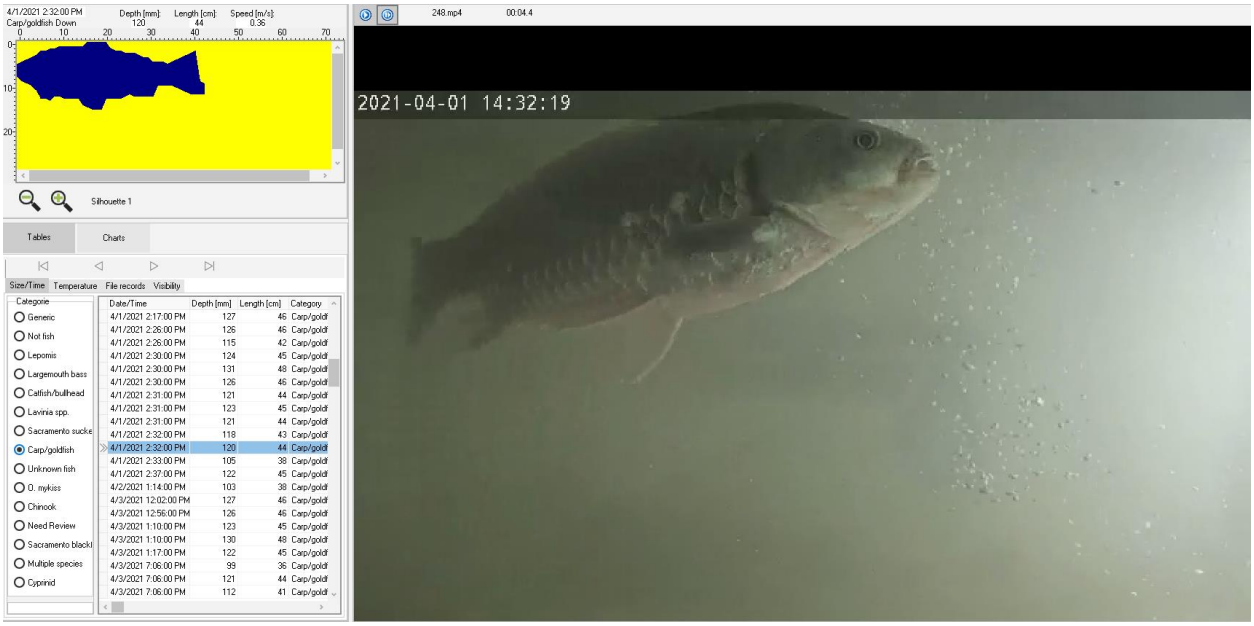



Figure B-9. Vaki video image of a Goldfish (*Carassius auratus)*.